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Chemical Notes.

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Alkalies.

There are substances of three kinds; one kind commonly termed Potash, Pearl-ash or Salt of Tartar, is contained in vegetable substances & is by Chemists called the vegetable Alkali. Another kind is Soda, or as it is more usually named the mineral Alkali. The third kind is the Volatile alkali, known by the names of the Spirit of Hartshorne, & Spirit of Sal Ammoniac. When I commenced the study of Chemistry - I found great difficulty in procuring substances - by their chemical names: that you may not encounter this difficulty, which is of no small importance - I have explained & shall continue to explain the popular as well as the chemical names - given to these substances. Thus as to Potash: - if you want it in large masses, you must ask - for Potash: - if in a more moderate quantity & purer - you can get it by the name of Pearl-ash. The purest kind is termed Salt of tartar. If again you want the pure alkali, ask for the strong vegetable caustic or

the causticum commune fortius. — I shall now detail the Natural History of the Alkalies — their Artificial History, their Chemical History & their uses — The alkalies are as old as the earth — In the oldest formation, in the substratum of the crust of the earth so far as we know it they are found — The Granite is partly composed of the feldspar — a component part of which is an alkali: they are also found in numerous mineral substances. They are found in all vegetables — that is when you burn the vegetable — for I am by no means

yes it does.

clear that the vegetable alkali exists in vegetables previous to their incineration. From 1800 tons of dry oak there can be procured one ton of potash — from 1200 tons of Hickory — one ton also can be obtained. Fir contains a great deal more — A Grass called Bernet yields a great deal of potash — All woods which contain resin have ~~none~~ potash — or comparatively very little — When Wood is first burnt — the acid & water

ry vapours are dissipated - & if the process is conducted in close vessels charcoal remains. When this is burnt where there is an access of any gas, carbonic acid is produced. There is some reason to believe that the alkali is formed during the incineration of vegetables, but it may possibly exist united with an acid in the vegetable itself. There have not been a sufficient number of experiments to decide this point. - The procuring of potash is a subject not sufficiently attended to in this State - Potash is sold in Europe procured from Norway - from Russia & from America. The former is carried chiefly to the ports of Riga & Dantzic - where it is called pearl-ashes, & blue ashes. Other parts of Europe are supplied generally from America & this chiefly from New York - In that state they have a process instituted for ascertaining the quality of the article - & when thus treated it brings a higher price than the Russian - In Penn^a as much land is cleared as in New York - in the latter state however the farmer saves his ashes - & I am certain tha

the ashes pay fully for the price of clearing the land; yet in this state the whole is entirely thrown away. At present thro' the whole state of Pensn.a there is but one establishment for procuring potash- this was instituted by Mr Lewis in the County of Lycoming. There they procure from every 14 lbs. of oak ashes lbs. 4 of potash-- & from the same quantity of hickory ashes- 6 lbs of potash - The process as conduct-ed by Mr Lewis is the following. Around a large room are placed a number of tubs- about 2 feet narrow at the bot-tom & 3 ft at the top. These are placed on dressers- they have false bottoms perforated with holes and placed on a ledge about 3 inches from the true bottom - On the false bottoms are laid poplar twigs- & over this a layer of straw- a stra-tum of lime is placed over this, which is to be well trod-den down - a stratum of ashes 14 inches deep is then added afterwards 6 inches of lime & so on ashes & lime alternate-ly till the vessel is filled. - Water is conducted to these tubs by a trough; being poured on the surface it sprea[ds] over it & gradually passes thro' the whole till it is col-lected between the true & false bottoms - from which it

is drawn off clear: As it goes on very slowly the whole of the potash in the ashes is dissolved - & as the affinity of Lime for carbonic Acid is so great as to abstract it from an alkali the liquor is tolerably pure or caustic. This liquor is conducted to iron boilers in the same apart-ment - there it is boiled down: When evaporated to a consistence the heat is greatly raised & the carbonaceous mat-ter is chiefly burnt out - It is then suffered to harden & is finally dug out - packed up in barrels & sold as potash When pearl ashes are wanted, it is subjected to a reverbe-ratory furnace by which the carbonaceous substances are more completely expelled - As procured here & in com-merce generally it much adulterated - thus in a manufac-tory of oil of vitriol at Manchester in Engd - I learnt that the sulphate of potash & sulphuret of potash left after the acid was formed - was washed so that all soluble matter might be dissolved - this was then crys-tallized & sold to the Salters who added it to their pearl ashes. In this way adulterations go on - & therefore when you wish any thing pure - you must make it yourself -

Potash then is an alkali procured by the incineration of vegetables growing at a distance from the sea; I am next to speak of an alkali produced by the incineration of plants growing by the sea side. This is very abundant in the whole class of the fuci & indeed all sea-plants some how or other contain Soda - which has been called the Mineral Alkali. Soda is the base of Glauber's salt, of the common Salt & of the artificial Soda Water. It is an alkali less unpleasant in its taste than the vegetable alkali and on this account is often preferred in medicine, especially as given in combination with the Phosphoric Acid. - The common property of the alkalies is to combine with acids - so that neither acid or the alkali is perceptible in the Compound - Thus Soda & muriatic acid form the common salt, which has neither an acid or an alkaline taste - It is the common property of the acids to turn vegetable blues red, & of the alkalies to restore the ~~red~~ blue colour. Here then we have a test of the presence of an acid or an alkali - Hence we have a

test by which we can discover the perfect saturation of an acid or alkali with each other — There are two ways by which we can distinguish potash & Soda from each other, A solution of Platina is precipitated by potash but it is not by Soda. Thus add solutⁿ potash to a solution of platina — a precipitate will be formed, but if a solution of soda be added no change will ensue.

The Acid of Tartar with one part of potash forms a very insoluble salt — the Cremor Tartari: with Soda it forms a very soluble one. Therefore if to the acid of tartar there be added a solution of Potash — a precipitate will soon appear — but should Soda be added no precipitation is produced — By these two methods we can readily distinguish between the two Alkalies —

The Volatile alkali is procured by distillation from animal substances — it is composed of Nitrogen & Hydrogen — When hoofs, — bones — skin or any refuse animal substance are distilled there comes over the Carbonate of Ammonia. The pure ammonia is known in the shops by the names of the caustic spᵗ of Hartshorne — the caustic Spirit of Sal Ammoniac &c &c The carbonate is

known by the name of the Sp^t of sal ammoniac - vol: smelling salts &c &c — —— The uses of the alkalies form the next point of consideration. The processes of making soap are not uniform in the different parts of the country, as they in most instances, do not understand the theory of its formation. In the common lye tubs ashes & straw are placed alternately on each other - water is then poured on till the solution is sufficiently strong. It is best however to have a false bottom 2 or 3 inches above the true one, which should be perforated with holes 1/2 an inch in diameter - If straw only is used it is soon destroyed by the lye - it is preferable to cover the bottom with poplar twigs - over which the straw is to be placed. In the common tubs lime is seldom used - but it is essential to the process: it can seldom be employed in excess - & ought always be equal to 1/3 of the whole. This converts the lie into a solution of pure potash by absorbing the carbonic acid; potash is absolutely necessary as no subcarbonate will unite with oil. Ashes should be well kept - if they become damp they are spoiled - A place ~~to~~ entirely built of

bricks is the best. When soft soap is wanted the fat & solutn of potash are merely boiled together, if hard soap the process is very easy, as soap will not dissolve when boiled in a solution of a neutral salt - if you boil a solution of common salt with a solutn of soap, it will become hard - & will separate - In making soap however the great object should be to separate the carbonic acid from the lye by means of the lime -

Equal portions of potash & sand mixed together & then melted - the mass being then ground & again melted form glass. Here in proportion to the purity of the articles employed will be the purity of the glass. When it is wanted very pure - a portion of red lead is added which easily parts with its oxygen - Here a singular circumstance occurs - when lime is used to remove the carb. acid & still some remains with the potash - this carb: or rather subcarbonate will injure the purity of the Glass - forming motes or specks in it - none of it will unite with the silex but if red lead be added the whole of its oxygen unites & combines with the glass. All this has given rise to the

opinion that flint sand or silex contains oxygen—& indeed it appears to be so in matter of fact: If we add an acid to an alkali in due proportions, the properties of each are destroyed—a compound is formed differing essentially from either of the ingredients: now in glass the alkali is neutralized by the silex—for neither the alkali nor the silex can be distinguishable in the transparent compound. Glass is coloured by the addition of other substances—yellow by ant[illegible] by silver, lead &c— violet by the addition of manganese in small quantities: red by a solution of Gold—green by copper: blue by the mineral substance Sapphire—an oxide of cobalt: & so of others— —

The Earths.

There are two kinds of earths—one possessing some of the properties of alkalies—the other possessing no alkaline properties. Thus they are divided into the Alkaline & Pure Earths—Of the former are Lime, Magnesia—Strontia & Barytes—these will readily unite with acids—destroying the peculiar properties of the acid & form

-ing with them Neutral Salts: they also turn the red colour of vegetables blue. Of the second kind are Alumine or Clay- Silex or Flint & 3 or 4 others of which very little is known: as zircon Glucine Yttria.

First of Lime. Lime-stone is Lime combined with the carbonic acid. I have on a former occasion stated how it could be separated- viz by an acid: I have also shown the quantity of acid in Lime stone about 44 pr Ct. I do not know whether I then pointed out the utility of this mode of decomposing lime stone. Supposing I wish to know whether there is any lime stone on a plantation- I take a piece of the mould- I burn it- dissolve or mix it with water- & then if there be any lime I shall know it by the taste- But if I take some of the earth & place it in a retort- pour on it some acid- if there be any lime-stone present- it will in this way be decomposed- the carbonic acid evolved may be collected, & by the quantity of this we can calculate how much lime stone is present. So that the weight of the acid becomes the exponent of the Lime.

Lime is an alkaline Earth. It unites with Acids, with the Sulphuric forming the Plaster of Paris, Gypsum or Sulphate of Lime; with the muriatic acid producing the Mur: of Lime; with the nitric making ~~Salt-Petre~~, Nitrate of Lime. The most important of these combinations is gypsum. This is found in the same relative situations all over the earth: it usually accompanies Rock Salt, running not exactly in contact with it - but in the neighbourhood: it is generally above the formation of the red-sand stone. It is not therefore to be expected unless in the same parts as the rock salt - & red stone. - Plaster of Paris is used in stuccoing: also as a manure, here it acts as a stimulus to the living fibres of the plant - by which its powers are increased - but it is not taking into the plant - it is not food - but a condiment. It will be useful to know how to distinguish between Lime Stone & Gypsum. If you scratch them ~~they~~ will

will feel very different - the Lime-stone being much the hardest - you can scratch gypsum with your nail. If you pour any acid on Lime Stone, it will drive out the carbonic Acid, all the acids unite with lime more strongly than the carbonic which is therefore expelled. But you may add any acid to the gypsum & no effect will be produced - as the affinity of lime for sulphuric acid is greater than for any other. If you bite plaster of paris you can powder it between your teeth. It is possible, that stones may be as soft as the plaster of paris & also not acted on by acids; these are in general argillaceous, & may be told by breathing on them when they will emit an earthy odour. But if any doubt should still remain we have a sure test. All decompositions of substances are effected by adding to them substances having a stronger affinity for their component parts. Plaster of Paris is lime combined with Sulphuric Acid, for which it has a strong affinity; but if I add carb: potash to the gypsum the sulp: acid will leave the lime to unite with the

protash — while the carb: acid being thus let free will unite with the lime — thus altho' the quiescent affinities are strong, the divellent affinities are strong-er. Then take a piece of Plaster of Paris, add to it 3 times its weight of Salt of tartar — boil them to dry-ness — repeat this 3 times, then wash the mass & filter the liquor; if the substance left on the filter be carbonate of lime, then the body tried was plaster of Paris but if no carbonate of lime remains, the substance was not Plaster of Paris. — Lime is a manure, when used pure & not as lime stone: it acts as the Gypsum be-ing only stronger. The use of lime is not in vogue in this country, as much as it ought to be: even in what are lime stone countries it is useful, as the surface is in reali-ty often found argillaceous. — Lime is used as a mortar or cement. Here it regains partly its carbonic acid & partly its water, & in some measure crystalli-zes as all bodies occupy more room in a state of crystalliza-tion, than they did before — so the lime acts as a cement

by enlarging the surfaces of contact & penetrating every crevice. — The second Alkaline earth is the Magnesia: this we got from the mother water of common salt-after all the salt has been seperated by crystallization; in this case there remains in solution another salt which is usually the muriate of Magnesia. Where it comes from I know not-whilst it is that the sea washes the edges of some formation which contains it. After common salt is seperated from sea water we have a solution of mur: of magnesia, which will not deposit crystals. If we then add a substance containing sulphuric acid, Epsom salt will be formed-which in its turn may be decomposed by the carb of Potash. The Carbonate of Magnesia is thus obtained. As a medicine no substance is so useful: the carbonate is tasteless, & do not mix so well with the fluids as the pure earth. This is procured by heating the carbonate till all the acid is driven off-it thus loses 7 parts out of 20 & is now called magnes: usta. It is very serviceable in indigestion, from which almost all our diseases

arise - as rheumatism & more especially the gout, for which it is almost a specific - It is very useful in cases of Stone & other complaints of the urinary organs.
Another earth of this class is Barytes. This particularly distinguished by its weight - from which circumstance it has been named. It is found here in small quantities but is chiefly procured from England. One peculiar property of it is, that it is a test for the sulphuric acid detecting always the minutest quantity of that substance. In Engd a solutn of the mur: of Barytes is precipitated by Vol: Alkali - & is employed as a white pigment which is said to be very excellent. I know of no other use to which it is applied.
Strontia is another of the Alkaline earths. It was first found in the Argyleshire in Scotland. Like Barytes it is a test of the Sulphuric acid - but is by no means so delicate. The peculiar property by which it may always be distinguished is the red colour which it gives to a flame when it is burnt. Neither it nor Barytes are employed in the Arts: at some future period when their properties are more known, they will prove of importan

The second Class of earths is composed of those which do not possess any alkaline properties: they do not change vegetable colours, they do not readily combine with acids, ~~an~~ they have no taste & no saline properties — The first is the earth of Alum: Alumina — Chemists have lately in a great measure agreed to have the names of all the earths to end in a: Strontia Barytia, magnesia &c &c. Alumina or pure Clay is so named because it is generally procured by the decomposition of Alum; which is a triple salt, having alumina for its basis. Clay is universally diffused. It is found among the oldest formations, being a component part of feldspar which contributes to the ~~for~~ composition of the granite which is the lowest stratum. Clay is found in all parts & indeed in almost every formation: principally in those which are disposed in laminæ or schistous as they are termed by geologists. In fact wherever a deposit — a formation or a mountain puts on a laminated appearance — there is good reason to believe that it is owing to the peculiar form of the crystals of argillaceous earth

We do not get it pure. The purest kind is that used in the Potteries. Pure clay is not found in the old forma-tions but is purer in the later or secondary ones. To discover whether it contains silex, rub it on the teeth, the least portion of flint will be manifest. For chemical pur-poses it procured pure by decomposing Alum. This salt is made out of the schistoes or laminated earths which contain iron pyrites. When iron pyrites consisting of equal parts of sulphur & iron is exposed to the atmos-phere - it is decomposed partly by oxygen partly by heat & also by water - The sulphur forms sulphuric acid - this unites with the iron forming the sulphate of iron or green vitriol. It is in this way that all the green vitrial from Engd is made - but this pyri-tes is more or less found in all argillaceous earth, especi-ally over coal mines - in these cases the acid formed by the union of the sulphur & the oxygen of the air instead of uniting with the iron - combines with the argill in this way alum beds are formed. The substance thus procured is ground - is then washed & filtered - it is

then crystallized. Some potash is usually added to facilitate this process. Now we can decompose this alum & get the pure clay: but in some places especially in Volcanic countries it is obtained purer - by the heat of the volcano it is sublimed & becomes more free from iron than by any other means. Hence the Roman alum is the best. Alum is precipitated from its solution by ammonia - the precipitate is heated & furnishes alumine.

When Alumina is pure it possesses all the sensible properties of dry clay: if you apply it to your tongue it adheres - by absorbing moisture. It is plastic, that is it can be moulded into any required form, it unites with nearly all the acids especially with the Sulphuric, - its combinations with this acid & also with acetic are the only ones which are much regarded - The compound with the Sulphuric acid is the common Alum. This has a strong styptic taste - & is much used in the processes of dying & ~~bleac~~ printing. Its use in dying is to fix the colour of the article - by fixing the colour is meant - the altering of the colouring matter so that it shall be no longer soluble in water - Alum does this by uniting chemically with the vegetable colour,

& forming a triple substance not acted on by air & water. The cloth is dipped into a sollution of a salt of alum — the earth adheres mechanically to the cloth, no chemical union takes place when a vegetable colour is added to this — the colouring matter is so changed that it is no longer soluble — but remains fixed on the cloth. Thus if Alum be added to a solutn of madder — a red precipitate will be formed — & so of others —
The Art of Printing consists in first — fixing mechanically on the cloth a solution of a salt of alumina. The Acetate is usually preferred — which is prepared by adding 2 parts by weight of Alum to 1 part of the sugar (of lead: a decomposition takes place — the Sulph acid of the Alum unites with the lead forming the sulphate of lead — which being insoluble is precipitated — while the acetic acid unites with the earth, forming the Acet: alum: which being soluble remains in solution. This acetas aluminæ is next mixed with some mucilaginous substance & stamped on the cloth in the particular form which is wanted — The acid of vinegar can be seperated by ~~vinegar~~ heat — for this

purpose the cloths are hung in a room of the tempe-rature of 80° or 90° by which the vinegar is driven off & the earth remains adhering to the cloths - there is no chemical union, for if you beat & shake the articles the earth will be beat out & dissipated. After this the cloths are are run thro' cow dung or sheep's dung to give a slight tinge & to prevent the earth from spreading. It is then rinsed - ~~&~~ afterwards immersed in a watery solution of Madder - this adheres to the whole surface but a chemical union only takes place where it meets with the alumine. If the whole be boiled - then the water will dissolve all the adhering madder - & the part ~~wh~~ originally stamped with the acet: of alum ^now^ will be left of a red colour. This is the foundation of the whole Process: that a chemical union should be made be-tween two or three substances where only a mechani--cal adhesion previously existed. This can be effected not only by alum - but also by other substances, as the oxides of the metals. Thus green vitriol will give a black colour - tin a red colour &c &c - In the back

parts of the country, it is often necessary for the inhabitants to dye their own cloths. If a red colour is wanted they use ~~bark~~ maddir if a yellow - hickory & oak barks - hickory bark furnishes the best yellow - & you should remember that the proper proportions are ℥iij of alum to ℔i. of the bark - madder will give a red - & the shades from a red to a chocolate to a dark brown may be obtained by mixtures of the maddir & green vitriol.

Alum is the foundation of all pottery ware from the coarse brick to the exquisite china - In this country - pottery is not very good - better however in this city than any where else in the U. States. In the country you can meet with no pottery which will hold milk if it is a little sour - or any acid whatever it may therefore be useful to know how to convert bad earthen vessels into good ones. Some years ago wishing some pottery ware to keep cyder in - I sent for bottles as they are usually made - I put one of them into a furnace - heated it for about an hour, & when it was

withdrawn it came out good porcelain - it would now strike fire with steel when before a tap would have broken it. Upon this I sent all my bottles back & paid for having them burnt over again. In this way my bottles would hold my cyder - & I have since kept my mercury in them for which they are sufficiently strong altho 40 lbs may have been in them.

In this country China Ware is not made - one general reason is, that wages are too high - persons here receive more profits & live much better than persons possessing an equal capital in Engd.. Indeed when we consider the numerous manipulations which are necessary there can be no wonder why this country will find it much cheaper to import than to manufacture their own China ware - In making the Liverpool ware the first thing required is to get the clay which is the basis. This in Germany - France & Engd is procured by analysis. The basis of the porcelain pottery is kaolin - this is formed from the decomposition of feltspar - which last is a component part of the Granite formation. The Granite is composed of Quartz feltspar & mica. Air has a peculiar

action on feldspar in consequence of the potash it con-
-tains - by which it is decomposed & forms the Kaolin.
In Engd they send to Cornwall for this - which is a
Granite country, & where it is a business of many to
collect it. It is however by no means to be found on-
ly in Cornwall the finest & purest specimens of this kao-
-lin is to be found all around this city - it is just as common
as any other stone perfectly adapted for the purpose of ma-
nufacture. It requires however too much labour & would
employ too many persons for the present state of our coun-
-try. - As this stone is found in Cornwall it is not perfectly
ready for the manufacturer, it must be washed & separa-
-ted from the undecomposed feldspar - from the mica &
quartz. It is then carried to the manufactory where it is
again ground & washed - several times to get only the finer
parts. The next thing required is to purchase flints & to
erect a furnace - here they are exposed to a red heat - & in
this state are immersed in water - & then ground to a pow-
-der - it is now a petro-silex or as it is termed a Chert
& breaks with a convex fracture: the powdered flint
is bolted that it may be obtained still finer & is then

kept apart. The clay as obtained by the repeated washings & still suspended in water is put into brick pans to dry over a gentle heat - but before it is dry while it is a puddle, the finely powdered flint is intimately mixed with it - It is then divided & again mixed - portions are taken off & they are thrown together again - & worked & kneaded so that the most intimate mixture may be effected. The Potter is now to mould it - one person for instance will mould the body of the teapot, another the handle - another the spout - another the ornaments &c. The ornaments are made by means of moulds. It is then placed in an open crucible & burnt. The glazing is then imbibed - after which it is again baked - the colour is now added - red is given by means of the crocus martis - many of the colours are given by lead. After this, if landscapes - heads - or other ornaments are wanted they must be printed - In the common method of engraving - a copper plate is engraved & the impress is taken on fine paper - here the printer's ink is smeared over the whole surface of the

plate = it is then wiped off, the ink remains in the little crevices - & the paper is stamped - For engraving the present landscapes &c - the plate is covered with the colouring matter instead of the ink - after which the stamp is made on paper as in the other case. Some now receive the paper & daub it on the ware - others apply it closer - thus it passes thro' several hands & the superfluous paper is washed off - it is then baked with a flux to fix the colour. — This is a brief account of the method of making the Liverpool ware. In this country it is of importance that we should assist the labours of the mineralogist in exploring the resources of our own country - Alumine is very plenty & of excellent quality in the back parts of our country - but the fact is nevertheless true, however strange - that the alumine which is wanted at Pittsburgh for crucibles in their glass works - is carried by land from New Castle on the Delaware. This is all I have to say on this earth & I now proceed to others of this Class.

Silex, Silica is an earth which is very common it is found in every formation & almost in every part of the stratum. It can be procured pure from from flint- transparent pebble - &c - it is procured nearly pure from the common gun flints. It will not unite with any of the acids unless very indirectly, it combines with all the alkalies, by which the properties of each are entirely destroyed & a new substance, glass is the result. Glass is obtained by fusing flint with potash or Soda - which of these is preferable is undetermined. A cheap method of furnishing soda has lately been adopted in Germany. Glauber salt is the refuse of several processes in the manufactures - & can therefore be obtained very cheap in Europe - when potash & silex are melted together a glass is formed - but is is supp[osed] that the best glass is made with soda - this however is not determined - when soda is wanted - a quantity of the Sulphate - or Glaubers salt is added to the silicious potash; the sulphuric acid unites with the potash - & the soda & silex combine - When glass

is wanted fine a quantity of lead is used. I have frequently fused barometer tubes with equal parts of potash the common salt of tartar — & of lamp-black from ℥j of these pieces of glass finely ground I have often obtained ℥i of metallic lead. The charcoal unites in this case with the oxygen of the glass & is converted into carbonic acid gas & flies off — & the lead seperated from its oxygen is therefore reduced. — Silex is soluble in 3 or 4 times its weight of potash; the potash must be in a superabundance — If I add an acid so as to saturate the potash, the silex will be precipitated in the form of a jelly. If exposed to a violent heat silex may be obtained pure from glass in the following way. Take a certain quantity — say ℥i of fine glass — melt ʒss with salt of tartar & lamp-black — in the first place you will get the lead — to ascertain the quantity of red lead that was present — add 14 pr Ct to the metal obtained, allowing for water. You then want to know the quantity of potash & flint: to discover this add to the glass 4 times its weight of salt of tartar well dry ... precipitate the silex by an acid — heat the precipitate

so as to dissipate the water & you will have the silex. You now have obtained the red lead & the silex - now the weight of the potash will be equal to the difference between the weight of the litharge & the silex together & that of the glass submitted to experiment. In this way silex may be obtained pure & the proportions of the several ingredients of the glass may be ascertained. — From the property silex possesses of combining with alkalies, of ~~uniting~~ obtaining with oxygen & of expelling carbonic acid - it has been conjectured & I think with great plausibility - that it belongs more properly to the class of acids than to any other. The basis of it appears to be oxygen - as by adding oxygen to it, it unites better with the alkalies. Hence red lead is added to it when fine glass is wanted. Silex is of essential use in all pottery as is well known - & I have nothing more to say about it.

There are some other Earths; which are however very little known & very seldom employed - I shall therefore do little more than enumerate them. There is an earth in the Emerald - which having a sweetish taste is named Glucina - It is found in analysing the emerald, which

is common in the granite of this country & in Germany. It is also obtained from the beryl - Its uses are yet to be ascertained. There is an earth obtained from the valley of Yttria in Sweden & has been named from that place. As I have never seen it - & as I believe it has never been seen in this country I shall nothing about it. - Zircon is an earth obtained usually from the island Ceylon. It exists in a false diamond used by the French to ornament their watches - It is also called Jargon - & is obtained from the crystallized Hyacynth. Mr Solomon Conrad has found it in an insulated near Trenton bridge in this country. It has not been employed in the Arts otherwise than as an ornament to watches - These are all the Earths. Having finished my observations on the Alkalies & Earths I proceed to the Acids.

The Acids are considered under 3 heads or divisions - The mineral - Animal & Vegetable Acids. The Mineral acids are those obtained from Mineral substances - & all consist of a base united with oxygen

Of these I have already noticed the Sulphuric, the Nitric & Muriatic when treating of the gases. Of the remainder the first to be noticed, is an acid forming a combination with iron which is very common in this country, especially about Baltimore: this is the Chromate of iron, from which is obtained the Chromic acid. It is always found in a state of combination - in which it exists in the form of an oxide - To obtain the acid - the chromate is ground with ½ its weight of nitre & then exposed for an hour to a violent heat - the acid of the nitre is decomposed & yields its oxygen to the oxide of Chrome which thus becomes acidified. It then unites with the potash of the nitre forming the chromate of potash; there are however always present some nitre undecomposed & some potash uncombined. To obtain it pure you must add Nitric acid to saturate the potash - & you will then have Nitre & Chromate of Potash: then by repeated crystallization the acid may be obtained — In going thro' the regular rout of analysis - it has been discovered that a yellow ~~liquor~~ precipitate is formed by adding the chromic acid to lead - which is a brighter & more

permanent colour than what is commonly employed. The common yellow is made by grinding together common salt & litharge or red lead: a muriate of lead is formed which being washed & heated form a good yellow – but is inferior to that procured by the chromate of potash & salt of lead: The nit: of lead is the best for this but being expensive the acet: is employed. You should be careful that all the alkali is neutralized by the ~~[illegible]~~ nitric acid as otherwise you will have a white instead of a yellow precipitate. The chromates are of various colours & will no doubt be hereafter much employed – An Acid is obtained from Molybdena which is a semimetal found in the primitive strata – The Acid is named Molybdic – but I have nothing to say about it. Arsenic can be converted into an acid, when boiled with nitric acid it ~~is~~ receives oxygen & is thus converted into a substance having acid properties. It is only used in medicine & will therefore be hereafter noticed.

Animal Acids. First the Prussic – this is ob-

-tained from the prussian blue. This is made by calcining the horns - hoofs &c of animals with ½ their weight of potash; this is then lixiviated - & a precipitate is obtained by adding to it the sulphate of iron, this is the prussian blue - ~~it~~ is improved very much by adding to it muriatic acid. The Acid is obtained by boiling a solut^n of the prussian blue ~~or red~~ precipitate may be obtained from the product Cyanogen a gas will be produced called ~~Kayali~~ the characteristic of which is that it burns with a blue flame - the acid may be obtained by crystallization -

It is of no use except in forming the prussian blue which withstands all acids - but is however soluble in ~~water~~ the alkalies. It will not therefore answer as a dye - as soap would speedily destroy it. The best blue dye is indigo - as this resists alkalies as well as acids nothing will attack it - it is the best & most lasting.

There are many other animal acids - of all of which hydrogen & Nitrogen forms the basis. You can obtain acids by ~~from~~ the distillation of all insects - but they are not ap-

propriated to any particular use; except in one instance, which I have heard of — In Germany they procure a very good vinegar by distilling ants — the mode of procuring it however will prevent its general employment. I ought to mention that I have good reason to believe, that the stings of wasps & bees is owing to the presence of an acid; as the application of chalk to the wound very speedily removes the pain — so quickly that it is only to be explained by supposing the presence of an acid which is neutralized by the chalk — Whether the explanation is correct or not, the fact is certain, as I know from my own experience that relief is obtained immediately by the above article. The idea afterwards arose in my mind, whether the poison of reptiles was not also of an acid nature; I have not made any experiments to ascertain this — but the idea is somewhat supported by the circumstance that the most effectual remedy in cases of poisonous wounds is the free external & internal use of the Vol: Alkal: — Dr Ramsay employed this with success.

The Vegetable Acids. There is an acid procured from Galls & hence termed the Gallic Acid. Gall nuts are a vegetable excrescence, the nidus of an insect which pierces the bark of the tree. They contain the principle which is known peculiarly & characteristically by the sense of astringency imparted to the tongue. This is also found in the different parts of the oak but is particularly resident in the Gall nut - & in the terra japonica - or extract of Catechu. This astringent principle is a Compound of two substances one strikes a black with the sulph: of iron - & the other which is generally but not always combined with it, is called tannin from being used in the process of tanning leather - & does not afford a black precipitate with green vitriol. It was formerly supposed that the astringent principle was homogeneous - but it is now ascertained, that the part which strikes a black colour is different from the part which makes leather. To separate these many very ingenious & com-

plicated processes have been employed - with however no decided success. We can get them together by dissolving the terra japon: in water or the Aleppo galls in Spt of wine or in water. It is this which is the basis of inks, as striking black with salts of iron. Any acid will destroy an ink by taking away the iron - Hence the use of acids in taking out iron moulds & hence also they have been employed to destroy writing - Thus the Gallic Acid & Tannin combined will ~~be~~ form a black with iron, but besides this they will precipitate from a gelatinous solution a substance insoluble in water. To explain this - I observe that if you boil calf's feet - you obtain a jelly - which is well known - but the parts of an old animal will afford a jelly as well as those of a young one thus the refuse of the butcher & carrier is bought up by a gluemaker who makes a jelly of them in a gross way. He places all these refuse animal substances in a large canvass bag - after being immersed in

lime water to destroy the hair – the bag thus filled is suspended by an iron chain in an iron boiler filled with water – It is now boiled, till all the soluble parts are dissolved which process is facilitated by occasionally pressing the bag by machinery. A jelly is thus formed – which is strained – filtered – boiled down to the consistence of the common jelly of your tables & while warm poured into troughs 6 inches deep – & of a width proportionate to the size of the cakes to be made – It is then allowed to cool & become solid – after which it is cut in proper lengths – & dried – by which process it contracts very much. A man having a frame with wires situated at proper distances is enable to cut a great number at one stroke – which are dried & form the common glue cakes. Glue therefore is nothing more than Portable soup. The soup is made precisely in the same way, the soluble parts of an animal are boiled down to a jelly – ~~are~~ the necessary condiments are added – when cool it is cut into pieces & dried. Glue then is the same as jelly – & is merely skin

dissolved in water - & is in reality the same as skin
Now I told you that what hitherto has been regarded as the astringent principle - will throw down from a transparent jelly, a substance insoluble in water - Thus to a Solution of Glue - which you have seen is a mere solution of skin I add a solutn of galls - a precipitate is formed - which being insoluble destroys the transparency of the jelly & finally falls down - this is exactly what you want in leather - something which will not be dissolved by any water it may meet with. Therefore the effect of adding a solution of galls to a gelatinous solution is to convert it in an insoluble substance which is leather. This solution of Galls consists of two parts - to separate them very many complicated processes have been employed. I have stated that the Gallic Acid will strike a black colour with green vit: - but will not throw down a precipitate from jelly. — Take a solution of raw coffee - this will contain the gallic acid ~~with~~ without the tannin - now if this be true, it will strike a black colour with iron - but will not precipitate glue - Here is a solutn of coffee - & a solutn of glue, I add

them together, you see there ~~is~~ no precipitate — Here is a solut^n^ of sulphate of iron - to it I add the coffee so-lution - you see there is a black colour immediately formed. Therefore the property of making ink is diffe-rent from that of making leather. — You can there-fore get the Gallic acid united with tannin, in the so-lution of Galls - you can get the acid seperately by ma-king a solution of raw coffee - As to the tannin I do not know that there is any process yet devised of obtaining it pure ~~or~~ seperate from the acid. — The Gallic acid therefore striking black with a solution of iron is the basis of all ink. I will give you what I con-sider the best method of making ink, with the chemi-cal reasons for my ~~than~~ opinion. — The Gallic acid is volatile - the carbonic acid of the atmosphere gradu-ally acts upon the iron in the ink & dissolves it, so that the ink in common use becomes ~~con~~ after some time of a yellowish rusty colour. To obviate this, there should be 3 times the weight of galls, as of iron; & boiling wa-ter should not be employed - as by it the acid is vapo-

-rated. The longer time the galls & vitriol continue together the better will be Ink, so that ink is blacker at the end of a month than when first made. The Gallic Acid & green vitriol when mixed give a brownish black colour - logwood & a solut^n of a salt of copper afford a blue colour - On this account to 3 parts of the galls one part of logwood & 1/2 a part of blue vitriol should be added: the sulphas ferri - & sulph: cupri will not decompose each other. You have now the colouring matter for your ink: which gives a blue black colour: The Gallate of iron however is not perfectly soluble in water therefore some mucilaginous substance is to be added that it may be suspended - for this purpose 1/2 a part of Gum arabic with a small quantity of loaf sugar is necessary; the sugar not only contributes to suspend the gallate but gives a freer stroke to the pen - brandy should be added to keep it from moulding. - Ink is therefore a Gallate of Iron. It is often employed in taking copies of writings - these are rendered much

more perfect by the addition of sugar. – All inks are destructible by acids, especially by ~~the~~ Chlorine. If it be required, that ink should remain permanent in the air & be changed by no chemical process there are only two ways of effecting this: one is by the addition of lamp black & the other ~~of~~ indigo. By either of these ways it will no longer be acted on by acids, or by the sun & air. The Antients employed an ink made of lamp black suspended in Glue – At Herculaneum it was found that altho' the scrolls were perfectly charred yet the atramentum or ink was still visible, remaining uninjured. To recover effaced writings you brush them over with an infusion of Galls. In all paper employed for taking copies it will be useful previously to dip them in a solution of galls. – Ink is the foundation of several dyes: when diluted it forms a gray – & by adding madder in various proportions the different shades of red & gray may be obtained. &c &c &c

Tannin is another ingredient in the solution of galls – When this solution is added to a solution of

skin - an opake precipitate is formed - which is insoluble - & which when filtered & dried is leather -

The process of making leather is this; Skin consists of the epidermis or scarf skin & of the derma or true skin - On one side there is an excrescence the hair - on the other cellular matter; the former is removed by means of lime - the latter is scraped off - The juices are pressed out - & the skin with the epidermis are boiled to a jelly - Oak bark is ground to a powder & then mixed with water - at first so as to form a weak solution - The skin is immersed in this - if it were a strong solution, the surface would be immediately corrugated - & the liquor would not act upon the whole skin. It is occasionally taken out & pressed & the solution is gradually made stronger: till finally the whole is fully saturated & rendered solid. Here the process is over in 4 or 5 months - but in England they continue it a much longer time - by which they make better leather - & as the weight of the leather is increased by absorbing the solution they make

a greater profit. In making thin leather for the soles of ladies shoes - an improved method has been adopted in France - it consists in boiling the leather - & then placing it on the surface of warm oil - the heat of the oil should be sufficient to produce an evaporation of the water in the leather - In this way - the water is driven from the leather - which becomes saturated with oil & afterwards impervious to water.

——— The Vegetable Acid which is probably the principal in point of importance, is Vinegar, or the Acetic Acid. Of this much is known - & a great deal remains unknown. It does not exist in ~~it~~ nature in a pure state - so far as has yet been ascertained. Its artificial History will therefore claim our attention. Vinegar is produced by the fermentation of the juices of fruits or of a solution of the soluble part of grains - All fruits & grains consist chiefly of carbon & hydrogen: & as being most economical the Distiller chooses Rye as the material out of which he makes his spirits & his vinegar - In the first place, he gets it coarsely ground - If it were ground finely - a paste would be

too easily formed when mixed with water - He in the next place, mixes it with a certain proportion of water - about 90 lbs to a hogshead - putting the grain in, with a small quantity of malted grain - In this country 1/12th part of malt is employed, in Engd however they consider better & more economical to malt the whole grain - The grain thus malted is mixed first with a small quantity of water of the temperature of 170° for if it were boiling the grain would be coagulated & thus much less of the soluble portion be obtained. In this way after some time a liquor is procured containing the greatest part of the grain. To this liquor, a quantity of yeast is added - yeast is a vegetable matter, in a state of fermentation - but so thick & viscid as not to allow of the free escape of the carbonic acid: for the theory of fermentation is, that the carbon of the vegetable unites with the oxygen of the air & forms carbonic acid which is evolved & in yeast also the carbonic acid for the above reason is contained in a very large quantity. When however it is added to a fresh quan

-tity of vegetable matter - the proportions are altered & the whole mass is quickly thrown in a state of fermentation: during which the atmospheric air uniting with the vegetable carbon - a large quantity of carbonic acid is generated. This is so much the case, that if you empty a tumbler filled with water over a fermenting vat - you will find that it will be filled with this gas. & Now as we know of no means of forming this gas but by uniting carbon & oxygen; & as there is nothing present but the vegetable substance & air, we have a right to infer that the acid gas is ~~procured~~ produced by the union of the carbon of the vegetable with the oxygen of the atmospheric Air. While this is going on Alkohol or Spirit of Wine begins to be formed, which is the object of the distiller. I am very much inclined to the belief that alkohol is always formed from sugar. Grain consists of two parts - If you take a piece of dough - & wash it well, till the water comes away colourless - you have then washed away all the starch & left the gluten. & Now it appears to me (from experiments - to be probable, (for it is not yet absolutely proved) that all the al-

-kohol comes from the starch. First. It is found by direct experiment that if you add oxygen to starch by means of the sulphuric acid- you will obtain a sugar. This I believe, was first done in Germany- Secondly. - If you take juice of the Maple &c- ~~or~~ ~~com~~ sugar & water- & cause them to ferment moderately you will obtain alkohol. Thirdly. - If you malt barley- it will acquire a sweet taste. The process of malting consists in keeping the grain moist for 30 or 40 hrs: till it swells- it is then placed on a floor till it germinates- & is then dried to prevent this process from proceeding. If you take a piece of barley & chew it- you will find it having the taste of wheat- rye &c &c if however it be malted, then it will have the taste of sugar- it is no longer starch. Hence I conclude, that starch is converted into sugar during the process of malting- I have therefore pretty nearly shown, that all alkohol, by whatever process obtained- is made out of a substance, similar to starch, for out of starch sugar is made & out

of sugar-alkohol. If this be true - it will become of importance to ascertain - whether the perfection of the liquor depends on the gluten or starch & whether some other article containing these substances in different proportions might not be employed more economically & more advantageously. And so also of bread, the question will rise, whether we cannot employ some other flour in making it - so that a better & cheaper bread may be obtained? - As to starch, there is at any rate, a singular fact - that if

be made with wheat flour they will grow heavy & spoil in a few days - but if made with the starch of the potatoe, they will keep light & good for 12 or 14 months - Now then, when the fermentation goes on as above mentioned, Alkohol will be formed - if however the atmosp^c air be freely admitted, so much carbon will be taken away that very little spirit will be generated: so soon therefore, as the atmosphere of carbonic acid is formed over the vessel it should be covered. The necessity of this has been ascertained by direct experim^t. — If then a

quantity of alcohol be formed - & the process be not stopped but allowed to go on, the alcohol will be decomposed - & by the further access of oxygen vinegar will be formed. So then every particle of acid is produced at the expense of a particle of spirit. The gradation then in the fermenting process is from starch to sugar - from sugar to alcohol, & from alcohol to vinegar. As we have proceeded thus far in the history of alcohol I think it will be most advantageous to you that I should finish what I have to say on that subject. — It is procured by distilling the liquors which contains it; the alcohol being the most volatile is first dissipated - affording an example of chemical affinity being destroyed by heat alone. It is then condensed usually in a spiral tube, called a worm, placed in a vessel of water - where water is scarce you will find it more economical to employ tubes passing thro' troughs - narrow at the bottom & wider at the top. The uses of Alcohol - are - for drinking - in this way a small

quantity may be advantageous - while the excess is injurious - whether on the whole it has been productive of more injury than good is doubtful. —

It is used also for making varnishes - For this it should be very strong. Alcohol is the solvent of resins - water of Gums. When we want alcohol very strong there are two modes of procuring it. - Alcohol will not dissolve any portion of a sulphate, nor of a carbonate - The pure or caustic alkalies are easily soluble in it - & from this solution we can obtain the alkalies pure - Now If you take the sub-carbonate of potash - (salt of tartar) & heat it in a crucible to a red heat - break it - & pour it into alcohol - the affinity of the heated alkali & water will be so great that they will immediately unite - This process being repeated once or twice will separate all the Water from the Alcohol - If the alcohol should dissolve any pure alkali - let some alum - very finely powdered, be added - the sulph.^c acid of this salt will unite with the pure potash & be precip.^d as sulphate of potash

the earth of the alum be insoluble will also fall down & the alcohol will then be left pure. For chemical purposes alcohol may be obtained strong by the second method which consists in distilling it over salt of tartar at the heat of 107° so that it shall come away slowly — drop by drop — In this way I have obtained it of the Specific Gravity of .792, when however it is of the Spe: Grav: .795 it will dissolve copal. — Alcohol will also dissolve the essential oils in this way forming essences & perfumes: but all these invariably give the headache & it is much better to employ the oils in their pure state — Æther is made by distilling alcohol with the Sulph: Nitric, or mur: acids: usually with the former. By conducting the distillation slowly & with caution a volatile, sweet spirit is obtained used only in medicine. I have lately heard of a beautiful experiment that has been made with this volatile spirit. It consists in heating a thin platina Wire to a red heat & then holding it over Æther without touching it — the ~~combustion~~ ignition of the wire will go on as long as any pure æther remains. The theory of this is — that by the heat, the

Ether is evaporated - & a stream of it passing over the
undergoes a slow combustion
wire in contact with the oxygen of the atmosphere supports
ignition
the combustion of the Platina. No other metallic wire will answer - 1st - they would more easily oxidate & 2nd - The heat would be radiated to a greater de-gree ——— ——— When the Fermentation of vegetable matters goes on beyond the point ~~at which~~ alcohol is formed - we have another substance produced vinegar - or the Acetic Acid of Chemists. The domestic uses of this are well known - On a former occasion I showed how vinegar can be deprived of its dark colour without injuring its ~~colour~~ strength or flavour - by sha-king it with ivory black & then filtering it.

Vinegar is used in making the Sugar of lead - in ma-king white lead & in printing Calico. The manufac-turers of calico have, of late, found that the acid ob-tained from the distillation of wood - is equal for their purposes to that usually employed. The acid so obtained is called the Pyro-ligneous acid: When used for the table it is purified by saturating it with

lime - percolating it thro' charcoal, burning it so as more effectually to destroy the carbon - & tar in its composition & finally decomposing it by means of the mur: sod: In this way I have procured some of this acid. ———

There is a very strong vinegar which deserves to be introduced. It is called Dr Henry's distilled, aromatic, vinegar - & is procured by distilling the crystals of verdigris - ~~the copper~~ it is completely freed from ~~it~~ copper by a redistillation - It at present, I believe is only used in some perfumes - ———

There are two or three other acids which are useful only as Chemical tests. There are some which will detect the presence of iron in its different combinations. The Benzoic Acid is one of these - & is used as saturated with ammonia. If you dissolve a certain quantity of iron in water & precipitate the solution by the Benzoate of ammonia - then by weighing the precipitate, you will know ~~how~~ the weight of the precipitate of a given quantity of iron - so that the precip-

itate will be the exponent of the quantity of iron held in solution. In this way you can not only detect iron in any mineral water but you can discover how much is present. The Succinic Acid is another test of iron - not so good as the former - but may be employed in the same way. The Oxalic Acid is procured by boiling Nitric Acid on Sugar, by which the oxygen of the acid is combined with the sugar, forming oxalic Acid. This is a delicate test of Lime - separating it from its combination with muriatic acid - which combination is very strong -

This finishes all that I have to say of Acids - there are several others which are little known & still less used - Your time can I trust, be much more profitably spent - than by attending to any thing which I could say about them - I therefore proceed to the consideration of Caloric.

Caloric.

Caloric is that which produces the sensation of heat. The word heat was formerly indiscriminately used to express both the cause of the sensation - & the effect or sensation produced by that cause. It became necessary to invent a word which should name the cause only, but unfortunately the name adopted involves a theory; as it supposes that there is some substance which is the matter of heat. Whether this be the case or not - we shall see presently. The question is, Whether heat is produced by a distinct substance - or matter - or whether it is only a property of matter & arising from an invisible, impalpable motion of the particles of bodies. A majority of Chemists embrace the opinion, that it is matter, "sui generis". Others - particularly among the English adhere to the Old English notion that it is only a property of all matter. At present in using the term caloric we appear to adopt the opinion of its being a substance but I would wish it to be understood - that I use it as it were, only for the moment - waiting for fu-

-ture observations & facts to render one or the other opinion the most plausible. I shall first notice the facts relative to its natural History - then those which regard its artificial History - its Properties will afterwards be considered, & we shall then be better able to investigate any theoretical opinion.

Caloric exists in two states - one called the caloric of temperature - the other native or combined caloric. The former is so called - because the temperature of bodies when raised or lowered is the exponent of the degree of caloric received or abstracted: but I shall show that caloric will exist in considerable quantities in a body, without its being ascertained by the feeling or by the thermometer. We find that caloric of temperature flies from one body to the other, is indicated by the thermometer - & by the difference of our feelings. It exists in all bodies, & is perpetually varying in degree, from climate, situation & various circumstances. — The First principal & most obvious source of the caloric of temperature is from the rays of the Sun. I believe that it is an axiom in Metaphysics; that there is no other

reason for ascribing to any phenomena the property
of a cause or to another that of an effect ~~#~~ except that
from observation the one is found regularly to proceed &
the other to follow — Now it is certain that heat is
increased by the presence of ~~A~~ the Sun, & is diminished
in proportion as it is partially or wholly obscured.
Hence we infer that the rays of the Sun are a cause of heat.
That the fact is so, is certain; there can be no doubt, that
the sun is necessary to the warmth of the atmosphere & of
all the bodies enveloped in it, but whether this is effected
by any thing directly emanating from the Sun or whe-
ther it is owing to an universal all pervading fluid,
put in motion by the rays of the Sun is the point in dis-
pute. It appears to be certain from late observations
& experiments that the Sun is a dense opaque body,
possessing like the planets an unequal surface with
hills & valleys, which are observable; that by the expe-
riments of Herschel it is surrounded by a luminous at-
mosphere. From this the luminous rays proceed; but of

what nature they are - how they proceed - & what is the connection between our atmosphere & that of the sun - are questions - which can be answered by no facts yet known - At the same time it is certain that there is a great quantity of natural caloric, already existing on the earth - pervading all matter - & is perpetually varying whether the Sun is present or not. When the Sun is absent - heat is felt - not so strongly - but as distinctly and as certainly - therefore the cause of this must exist when the rays of the sun can no longer act as a cause. So also we can excite heat independant of these rays. Hence it is probable that something exists - which is the matter of heat - that it pervades all bodies & is made sensible by the sun's rays. - Unless we take for granted that it is a matter "sui generis" we cannot account for facts. Mess.rs Euler & Huygens were of opinion that heat & light were fluid bodies pervading all space - & all substances - & is brought into action by various exciting causes.

We find that heat exists naturally - accompanying thunder & lightning - & also attending chemical decom

-positions in the bowels of the earth. I place these two sources together as I believe that both are conducted en-tirely on chemical principles. — There is no inflam-mixture of gases made by the Chemist but what can be fired by electricity. There is no doubt of the existence of hydrogen of oxygen & of electricity in the atmosphere & where these are accumulated the phenomena of heat will appear — for it is generated in any & in every case where oxygen unites to an inflammable base, lightning there-fore I consider as arising from electricity accumulated in the at-mosphere & acting on the gases which it there meets, thus forming water. This opinion is the more probable, as there is always a considerable increase of ~~the~~ rain after a clap of thunder. The thunder is easily accounted for by the suddden rushing in of air to fill up the va-cuum produced by the condensation of gases. I do not know that this explanation of lightning is the true one, but it is very plausible & much superior to any other that has yet been proposed. Heat is also na-

turally produced by decompositions going on in the bowels of the earth. The "bowels of the earth" is a figurative expression - & by it we mean only the crust of the earth - About the Nucleus of the earth we know nothing - plausible conjectures have been made of its specific Gravity. Experiments made by great philosophers & made in different ways & on different principles - give us good reason to conclude that the Specific Grav.y of the Nucleus is about 5 - & that of the crust is about 3 1/4. But whether the nucleus is a ball of fire or what it is we have no knowledge whatever - In our reasonings therefore we must go only on what we do know: In the crust of the earth we find as sources of heat, Warm Springs. & Volcanoes.

Warm Springs are found in almost every quarter of the Globe - At Geysers in Iceland Water of a temperature greater than that of boiling water is ejected to the height of 90 feet - & in a column 19 ft ~~of~~ in diameter - it is so hot that it holds silex in solution. Warm

Springs are also found in Engl^d - & also in this coun-
-try in Virginia. Now these must have acquired their
heat from something in the earth. Nature has so many
ways of executing her own phenomena - that it is absurd
for us to confine her to any particular way. But still
as we can only reason from what we know - from what we
can execute in our petty laboratories & from what we can
occasionally observe going on in the great Laboratory
of Nature, we may venture to hazard a conjecture of
the method pursued in producing natural phenome-
na - I believe that most warm springs are found
where there is a great quantity of Iron pyrites - & in
Volcanic countries where sulphur exists in abundance
We know from direct experiment - that where sulphur
iron & moisture get together - the heat produced - is
truly prodigious: ~~as~~ in this way we can & have made
artificial Volcanoes - & by this process all the green
vitriol of commerce is obtained — When sulphur
iron & moisture are mixed - the moisture is decomposed

× Erroneous both in fact and inference

& its oxygen unites with the sulphur - In which process heat must be evolved - as where-ever oxyⁿ & a combustible base unite - a combustion takes place - sometimes this in a moderate degree sometimes fire & flame are elicited - Therefore we need not proceed any further in our investigation - for this will explain very satisfactorily how the springs will be heated -

In all cases after a sudden rain or shower, there is a great sultriness in the air. This appears to arise from the heat given out by the sudden condensation of gases. — It has been observed that the heat of climates depends on two circumstances - their situation as regards the Equator - & to the progress of cultivation. It appears from the History of civilization that the cultivation of the land lessens the degree of cold; in the classic authors we find more allusions to ice & snow - & greater compltˢ made of the severity of the seasons - than we can possibly imagine would have been the case under present circumstances - Italy now enjoys a much milder climate than during the times of Virgil & Horace. It appears also to me that there has been a gradual change in the

climate of Lond^n^ during the last 25 yrs that I have been a resident in it, so that upon the whole, it is considerably more mild. Heat & combustion are not only produced by chemical decompositions in the regions of the air & in the bowels of the earth but also by the contact of different substances - cotton & oil - flax & oil - charcoal moistened with oil &c &c will often fire spontaneously - & I have no doubt that many buildings, especially manufactories have been ~~often~~ destroyed in this way - the burning of which has been attributed to evil design - In Eng^d Hay stacks often take fire That climate is so moist that the grass is seldom properly dried in consequence of which - assisted by the weight of the stack the moisture is decomposed - the oxygen is imbibed by the hay which becomes charred - the hydrogen from the heat generated fires - & the whole is thereby in fl^d

—— There is a kind of spontaneous combustion of the human body - arising from the excessive use of ardent liquors - There are 8 or 10 cases well authenticated & recorded of persons being actually

consumed by the decomposition of the moisture of their own bodies - & that the bodies were changed to charcoal dust. The facts are notorious ___

Heat is naturally produced by the decomposition of carbonaceous matter & vapour where carbon is collected in large quantities - as in coal mines. This I have noticed when speaking of ~~Sulphurated~~ carburetted Hydrogen The source of heat is the carbon uniting with the oxygen of the decomposed moisture. ___

Heat also is naturally produced by every process of an organised body whether animal or vegetable. To explain the production of heat in our bodies - many theories have been formed - The first & most probable was Crawford's. He discovered the capacity of bodies for different degrees of heat - & also that oxygen possessed a very great capacity for heat. Hence ~~the~~ he concluded that the air of the atmosphere is decomposed - that its oxygen entered the blood & that heat was gradually evolved by the union of oxygen with the blood in the progress of the circulation - This altho' very ingenious, does

not answer precisely to facts. It is uncertain how much oxygen enters the blood - a quantity of carbona-ceous matter is evolved during respiration, & by this theory too all the heat would be evolved in the lungs & not gradually through out the body. Many experiments have been made on this subject - As I stated on a former occasion - that in every chemical combination there is a change of temperature, & that generally that heat is evolved, especially when the change is from a rare into a denser substance; it is on this principle that I would explain the heat of animal bodies. In every part new chemical decompositions & recompositions are continu-ally going on - & solids are formed out of fluids. Now in these various changes agreeably to the above principle heat must be evolved: & as these actions are taking place in every part - so every part gives out its portion of heat - which will I think fully account for the temperature of the animal body - Of this more hereafter - The same reasoning applies also to vegetables - all this will

be more evident when I come to speak of the power of living bodies whether animal or vegetable, of resisting to a certain degree the ~~extra~~ increase of heat & cold.

Having now noticed the means by which heat is generated naturally — I proceed to the artificial means of procuring it. — In the first place we procure it by combustion, by setting fire to bodies. When two bodies meet, one being already on fire, & the other combustible — as when a lighted match is applied to dry shavings the process which goes on, is entirely chemical. You have seen that unless oxygen is present no bodies will burn & burning bodies would be immediately extinguished. In all cases oxygen maintains combustion — & this it does not by remaining but by combining with the burning body & entirely disappearing. We can only argue to cases not perfectly known, from cases which we do know — we know that by burning phosphorus in confined portion of air — that the oxygen of the air disappears — now as it could not escape thro' the vessel — it must have been absorbed by the phosphorus — by which the phosphorus is con-

-verted into Phosphoric Acid - & has its weight increased. As we see all this, we have a right to transfer to all other phenomena of the same nature, the same reasoning - & to conclude that Combustion is a chemical process in which oxygen & a combustible base are united. When this union takes place suddenly - it is accompanied by heat - light & other phenomena - none of which are evident when the process goes on very gradually - But the question arises - Whence comes all this fire & flame? whence all this heat? - I must anticipate a little what I shall soon demonstrate to you - & observe, that the effect of heat is to dilate all bodies - thus the spirit thermo^r & the mercurial thermo^r are both useful, by the fluids they contain, occupying a greater or less space according to the degree of heat to which they were subjected. All metals are acted upon in the same way - a tin cylinder when heated will not pass thro' the same orifice that it would previously. I have shown you also, that a change of form is produced by heat - as when Ether is exposed to a certain degree of heat - a permanently elastic gas is form

-D. Hence all bodies are rarefied by caloric. If this be so, then all bodies that are rare, must ~~be so~~ assume that form from being combined with heat: for nothing else has been added to them: Heat must also be required to keep them in that state, & being combined is not sensible to the feelings - & does not affect the thermometer. Mercury when frozen & in a solid state is about 15 times heavier than water, when heat is applied & it is rendered fluid, it remains permanently so - & is then only 13½ times heavier than Water: thus also ice - is converted into water by combining it with heat = abstract heat, & ice will be again formed - by adding a greater you convert it into vapour which will remain so, till it meets with some substance to separate the heat - from it - when it is condensed, again forming water. All these facts show that heat is permanently combined with bodies: & therefore when a gas is converted into a liquid or solid - the heat necessary for its existence as a gas - is no longer wanting & must therefore be given out - Now experiments have been made on the different capacities or affinities of bodies for heat - & it is found that if atmospheric air be one, oxy

-gen will be 4. & hydrogen will be 21. & we may suppose that the more rare & lighter a body is - the more heat will it hold permanently combined. A certain quantity of heat is necessary to change ice into water - ~~to~~ a quantity indicated by 140.^{d} of the thermometer - yet the temperature of the water is not increased by this, but remains at 32°. the temperature of the ice. What becomes then of this 140° degrees of heat? It must have entered into chemical combination with the ice. In like manner when the gases are converted into water, the heat which is combined with them as gases, is evolved. — When I set fire to dry shavings, what do I do? I enable the oxygen of the air to combine with the shavings - these consist of hydrogen & carbon chiefly; both combustible substances, the oxygen therefore uniting with these combustibles is condensed - & must give out the caloric, which was necessary for its existence as a gas. Such is the theory of combustion; Hence the fire, flame &c occur only when the combustion is very rapid. As to light & flame I shall have to say more when speaking of Light. At

present I may observe that all vegetables imbibe light, which combines with them. This is evident by tying up the head of a lettuce, so as to prevent the access of light you will find that it will be perfectly white & different from the leaves exposed to the influence of the light & air. All the colours of plants depend on light. Hence there is strong reason for believing that light is imbibed — & is given out during the process of combustion. ——

Some practical applications may be made from this view of Combustion — Houses are often on Fire: in such cases — before it has advanced too far — all the doors & windows should be shut — to prevent the access of oxygen. When a chimney is on fire — the placing a wet blanket over the fire place will be very effectual in extinguishing it by destroying the current of air. On this principle patents have been taken out in Engd — for securing houses from fire — it is by shutting up all the cracks & crevices in the walls & floors by means of sheet ~~iron~~ or a thin coat of plaster — laid under the boards of the floor & in the walls — I have seen the experiment in a wooden house erected for the purpose — two tar-barrels were fired in the room below, while that above

remained uninjured. The light combustible dresses of females are very dangerous, if they should catch fire — a horizontal position should be immediately chosen & a carpet be rolled around the person —

We also produce heat artificially by means of Lens & of concave Mirrors. In Engd Mr Parker had one of glass which cost him 700 guineas. It was very large, solid & uniform except a little defect at the edge, & was the most powerful ever made. It is not indeed probable that another one could be made; but there is one which I think could be made again instead of being solid — it was composed of two glasses about 3 ft in diameter & made like Watch Glasses, these were cemented together by their edges — while the interval was filled with alcohol.

These Glasses are useful only for Chemical purposes, thus Dr Priestly wishing to ascertain whether diamond was carbon or not, He melted some diamond powder in a vessel over mercury in a given quantity of air. The diamond entirely disappeared — There were no remains — the air was not found to be diminished but to be changed into

carbonic Acid. There are no practical purposes to which the Lens can be applied ——

Heat is artificially produced by Frictions. If a blacksmith hammer very quickly on a piece of iron, the iron will become of red heat, so that a match can be ligthed ~~at~~ this arises from compression the heat is as it were pressed out of the atmosphere precisely the sam way, as in the condensing tubes for firing spunk — a certain quantity of air by means of the piston is suddenly & rapidly compressed into 1/4 1/20 its bulk — It is thus changed from a ~~dense~~ rarer into ~~an~~ a ~~rarer~~ denser substance — & of course heat is given out. So in the case of friction, I believe the heat produced is owing to the sudden condensation of portions of air by the strokes of the hammer. I know of no better method of explaining the phenomena —

Count Rumford, who thought that heat was not a substance "sui generis," but with Newton & others that it was a mere modification of motion among the particles of a body invented an experiment to prove this opinion. In a given quantity of water he immersed a brass cylinder — By means of a water wheel — he pressed with

great force the blunt end of a steel piston - & thus caused it to move with such velocity that a quantity of heat was generated sufficient to boil the water. He thought that was conclusive, for whence comes the heat, there is no air from which it could be procured, there is no oxygen which was supposed to be the grand reservoir of heat -

He appears to me - however - to have forgotten that the water as well as air contains caloric in combination; Wedgewood was of the same opinion & he took to prove it - a piece of glass which, he said, contained no oxygen & pressed it very firmly against a grindstone turning with velocity. Heat was produced in a great abundance - but he did not consider that this proved nothing - as the experiment was made in the air - & also as the glass actually does contain oxygen.

Heat is also produced by the compression of substances. In blast furnaces where bellows were formerly employed in the fusing of iron - it was found that the stream of air produced in this way was so varied, that the metal was very different. Instead of the bellows they

condensed a large body of water in a strong stone room this was pumped up into another room filled with air & perfectly close - so that in this way a regular pressure was made & by it an equal blast of air could be constantly produced. Now it was found that by the pressure the temperature of the confined air was considerably increased. — Heat is also produced by firing oxygen & hydron gases by electricity. It is also produced by the action of a pair of bellows.

The Properties of Caloric of temperature —

The particles of Caloric repel each other - so as in a certain degree to be dilated. It tends to an Equilibrium - that is, it flies off from a body which has it in excess to a body which has a less quantity - until both bodies are of the same temperature. This will be done more or less slowly in proportion to the conducting & radiating powers of different bodies. — Caloric, by its repulsive power destroys or weakens the attractions of cohesion & gravitation. That it destroys the attractn of cohesion is evident in all cases of volatilization - sulphur,

benzoin camphor &c &c when exposed to heat alone have their form destroyed the attⁿ of aggregation is overcome & they appear in the finest powder. In this case also we see that the attracⁿ of gravitⁿ is overcome by caloric for the sulphur camphor, &c immediatelly rise in the air in opposition to gravity. That it overcomes these attractⁿ is evident also in the common method of distillg alcohol: In fact all attractions are overcome by caloric so much so, that some Philosophᵉʳˢ have supposed, that caloric is the source of the centrifugal force: but this is established by no facts or arguments. Sometimes it counteracts & sometimes it assists Chemical Affinity. When the repulsive power of heat is greater than the affinity of two or more bodies to each other, these are seperated - chemical affinity is counteracted - is overcome. this is the case in distilling alcohol from water - But when caloric so destroys or weakens the attracⁿ of cohesion in a body as to enable another substance to act upon it more easily - it then assists chemical affinity.

Heat is transmitted thro' some bodies without any

interruption as thro' the airs & gases: thro' ~~a~~ others, its pas-
-sage is interrupted & it proceeds more slowly - it is then
said to be conducted. Some bodies conduct heat bet-
ter than others - thus charcoal conducts heat very badly - a
portion of charcoal may be red-hot - while the opposite
end may be held without injury: metals are good conduc-
tors of caloric if one end of a piece of metal be heated, the
heat will quickly be evident at the opposite end. Hence in
Winter we employ bad conductors of heat for our cloath-
-ing - as wool & silk. Hence in cold countries they have
double sashes to their Windows, that a plate of air may be
interposed which is a very bad conductor. By some bo-
dies heat is interrupted in its progress - & absorbed, as by
those which have an attraction for it: by some it is not
interrupted. Altho' in the focus of a Lens, both heat &
light are concentrated - yet if a piece of glass be held
before a fire - the light will be transmitted - but the
heat will be retained. Caloric is reflected by some bo-
-dies - as by concave metallic mirrors - a table spoon well
polished will reflect a considerable quantity of heat -
It is true, that I have been lecturing as if there were no

doubt of the chemical theory, that heat is a substance;
Newton Hope, Davy & many others deny this - & maintain that heat is merely a motion among the particles of a body.
This may be true - but if true, I cannot lecture - I must suppose that it is something - before I can tell you anything about it. I hold a tablespoon to a heated body & I find that heat is concentrated: now what is concentrated? Is it motion? - motion is the property of something there is no motion unless there be something to be moved, What then is moved? the air - but the air is always in motion - & yet no heat is produced - besides I do not know that air can be reflected - & refracted - In lecturing to you therefore I must consider heat as a substance so that I may be able to describe its properties —

Heat is radiated by some bodies - passing off from them in radii - or lines from a centre. Of this more presently. — When heat is not accumulated in large quantities - & where it remains for a short time - it produces no chemical change - on bodies, which reflect conduct - transmit or absorb it. Heat expands all

bodies in different proportions - the expansion generally being inversely to the ~~constant~~ attraction of cohesion. There is some reason to believe that the particles of fluids are spherical touching each other consequently in points only the fact however is that gases expand more than liquids & liquids more than solids. As bodies contain heat & are expanded by it there must be space, - that is there must be interstices between the particles which are enlarged or diminished according to the quantity of heat present - Bodies on losing their temperature, contract & become denser, as is evident when gases are converted into fluids. Alumina forms an apparent exception for when heated it contracts - Wedgewood has employed this earth to measure high degrees of heat - as it is observed to contract very regularly under these circumstances - His pyrometer for a time was much used, but from some cause has now gone out of vogue. Heat can be forced out of a body by pressure - thus if you take a cylinder closed at one extremity & having a piston accurately adapted to the other - a sudden stroke on the piston will condense the air between

it & the closed extremity - the consequence of which heat is given out - & will inflame any light combustible matter, a piece of punk is usually employed. — All dense bodies can be heated more than rare bodies, because in the same space; there are more particles to be heated: & dense bodies do not expand so much as r are ones. This is one reason, why the cold is greater in the higher regions of the Atmosphere, the air at the surface being much more dense -

All bodies passing from a rarer to a denser state give out caloric, which now becomes caloric of temperature, but in changing from a denser to a rarer state they absorb caloric - which becomes combined with the body & is no longer sensible — This proposition will be exemplified by the following exp.^t: To show, that liquids when converted into gases absorb heat - Let Æther be exposed to a certain degree of heat - you will find that in a short time it will be converted into a permanent gas - now as nothing but ~~gas~~ heat has been added to the Æther, it is manifest that the gas produced must be a compound formed out of heat & Æther chemically united ~~&~~ therefore heat is absorbed —

To show that gases when converted into liquids give out heat - let a quantity of Muriatic Gas be collected over mercury - & pass up a portion of ice - the ice will be melted by the heat given out by the condensation of the gas - for the muriatic acid gas is readily ~~soluble~~ absorbed by water - The heat therefore necessary for the existence of the acid as a gas - is precipitated by converting it into a fluid - so you see both by synthesis & analysis - that it is caloric which gives rarity to bodies - Again if I mix water of one degree of heat with an equal weight of water of another degree of heat the temperature will be the arithmetical mean - Thus If water at 70° - be mixed with an equal weight of water at 190° - the temperature of the mixture will be 130° - but if I add to a pound of ice which is always at 32°; 1lb of water at 172° - the temperature when the ice is melted will not be the arithmetical mean 102° - but it will be only 32° - therefore 140° of heat has disappeared - while a pound of ice was melted that is 140° of heat is absorbed by a pound of ice during its conversion into water - Thus also when wa-

ter is converted into steam a quantity of heat is absorbed - & on the contrary when steam is converted into water - a great quantity of heat is extricated - Thus If - I take ℥xvi of water at 70° - & pass thro' it ℥i of steam, ~~then~~ the temperature of the water will be raised to 122° - having therefore acquired 52° of heat - that is - each of the 16 parts has received from the one part of steam - 52° - therefore 52° - multiplied by 16 will give 832° - the quantity of caloric contained in the steam. This, allowing for the quantity taken away by the vessel - air &c - is very near what Mr Watt stated - 900° - to 950° —— Hence all solids during their conversion into liquids produce cold - It is thus that artificial cold is frequently produced; with this view ice & salt are mixed together - when the ice melts - so as to dissolve the salt - it is necessary that heat ~~must~~ be absorbed before the salt will melt - this heat must be furnished by surrounding bodies which are therefore rendered cold & are frozen — so also fluids produce cold - when converted into the state of a Gas ——

"Wherefore gases, vapours, & fluids, being condensed, give out heat - as muriatic acid gas, mixed with ice is absorbed & gives out heat in sufficient quantity to melt the ice immediately. From these facts & principles arose the theory of making ice by means of saline mixtures: of cooling fluids by means of Egyptian coolers, which are slightly porous - allowing the fluid to exude slowly - by the evaporation of which cold is produced. So also ice is made by evaporating ether; the ether should be good, that it may evaporate speedily - it is seperated from Sulphuric alcohol Acid by washing it with water - the quantity of water to be frozen must be small - & the evaporation of the ether be hastened by placing the whole "in vacuo". Hence dense bodies do not contain & do not require so much caloric as rare bodies - & hence density & rarity are mere terms of comparison, expressing the relative quantity of caloric in the substances alluded to -

The capacity of bodies for heat depends on their denser or rarer state: if a certain quantity of caloric is necessary to convert a fluid into a gas - the gas may

have a greater affinity for caloric than the fluid, as it contains a greater quantity.

Of the radiation of caloric; it is sent off in parallel lines from plain ~~sur~~ faces - obeying the same laws as light - & in a radiated ~~form~~ lines from a concave surface - The nature of the surfaces influences the radiation of caloric - According to the experiments of Leslie po-lished surfaces radiate with difficulty - rough - & blackened surfaces radiate much more readily. Hence all culinary vessels which are to contain liquids warm for a long time should be very bright & clean. Caloric is absorbed by surfaces which radiate perfectly - Thus in Franklin's experiments - the black cloth sunk in the ~~snow~~ snow & of course absorbed more heat, than any other colour - The progress of heat is not affect-ed by a current of air - Scheele ~~Schield~~ found that when a strong current of air was directed towards ~~the~~ stove the thermometer was ~~rais~~ influenced equally as when the air was undisturbed - air is one thing - caloric is another - Pictet found that caloric affected the ther-

-mometer instantly - at the distance of 69 ft - Caloric is refracted in passing thro' bodies - It is reflected from concave metallic mirrors - not from Glass mirrors - in its reflection it obeys the laws of light - as ~~has~~ was shown by Mr Pictet - He placed a heated body in the focus of a concave metallic mirror - a second mirror of similar nature & size was placed parallel to, & fronting the former - a thermometer in the focus of this last was affected immediately by the heat of the body in the other focus - which was reflected from one mirror to the other & again concentrated in its focus - If a cold body be substituted for the hot one - the thermometer will indicate a decrease of temperature - as if cold was radiated - but this is better expd by the supposition of the heat being carried from the ~~cold hot~~ thermometer to the cold substance. — It was formerly observed (page 228) that metals were the best conductors of heat - this power varies in different metals - some conducting it more readily than others - this is seen by covering the extremities of rods of different metals ~~~~ but of

the same length & diameter with beeswax, let the oppo-
site ends be heated the wax will melt first on that
rod which possesses the best conducting power —
Liquids also conduct heat; chiefly however by the
motion of their particles — Water however will con-
duct heat downwards, altho' very slowly. This was proved
by Murray & Thomson — who found that a thermomr
was affected — when placed at the bottom of a vessel
110. of water — by heat applied to the surface — Count Rum-
ford however maintained that heat was not conducted by
fluids but that it ~~over fro~~ was communicated to the
mass merely by the motion of the particles —
The Sensation of heat & cold depends partly on
the conducting power of bodies — & partly on their den-
sity — If a piece of metal & ~~ch~~ a piece of charcoal be
of the same temperature — the ~~latter~~ former will appear to
be the colder — as its conducting power is the greatest,
if a match be red hot — & you touch you will be
burnt — but if gold be raised to the same tempera-

-ture you will not only be burnt but the part will be destroyed - the density of Gold being greater - a greater number of particles are heated in the same space

The expansion of bodies when heated varies - but this variation does not depend on the quantity of heat communicated - the fluid in an air thermometer will be expanded much more by the same degree of heat than the fluid in the mercurial thermometer - It is this expansion by heat that converts solids into fluids & fluids into vapour - calorie being removed the bodies are proportionally contracted. —

Latent or Combined Caloric. When an acid is added to an alkaline liquor - it will take up a certain quantity of the alkali - in the same manner, if caloric be added to a body a portion of it will disappear - & the remainder will escape as caloric of temperature - When an acid & an alkali saturate each other the acid is not annihilated, it is latent - it has only disappeared - & can be again produced by adding any substance which will remove the alkali - In the

same way. calorie is not destroyed - but becomes latent in a body. It has been much disputed whether a chemical union takes place under these circumstances. That it does I think probable from the following considerations - 1st - That calorie will combine with a body to a saturating point. forming a neutral substance - the caloric disappears - as an acid does in forming a salt - 2nd Caloric alters the forms, shapes characters &c of bodies; as when ice is converted into steam - when hydrogen is united to zinc &c - 3rd Caloric has its saturating proportions - 4th It induces an alteration of temperature in surrounding bodies - 5th Caloric has specific affinities which vary according to the nature of the substances - 6th It enables substances to exhibit affinities they had not before - as hydn - by it is enabled to take up zinc & iron. These are my reasons for inclining to the belief that caloric when latent is chemically combined - If mercury be cooled from 96 Fahr

it becomes solid it will lose 135° of heat which will not be indicated by the thermometer. So also if to a pound of ice at 32° be added a pound of water at 172° the temperature of the mixture will be only 32° so that 140° have become latent. — In warm weather the evaporation of the fluid from the sides of a vessel in which it is contained had been condensed, will render the fluid in the vessel colder as a quantity of caloric is absorbed & becomes latent in the evaporating moisture. In this way the rarefaction of fluids is at the expense of the caloric in surrounding bodies. Specific Caloric, by this is meant the relative quantities of heat in diff^t bodies — Equal weights of the same bodies — at the same temperatures contain equal quantities of caloric — but equal weights of diff^t bodies under the same circumstances contain diff^t quantities of caloric — —

The next subject to be noticed is Light — When the rays proceeding from the sun or any luminous body thro' the watery lenses of the eye — the sensation communicated is called Light — By a lens is meant

a solid or liquid, transparent medium - convex at least on one side - The sensation produced by a ray of light thus passing thro' the lenses of the eye remains for a certain time - This time has been calculated from experiment to be 1/400th part of a minute - If a coal of fire be made to revolve - instead of observing only one luminous point - a circular ring of fire will be seen. Hence the impression on the retina remains during the time that ~~the~~ is occupied in making one revolution - By direct calculation from this experiment of M^r D'Arcet - it is proved - that the particles of light may be 20'000 miles distant from each other - & yet a continuous impression be made on the eye - As will be more fully noticed presently - This impression we are instinctively & constitutionally forced to refer to some cause "ab extra" - something without - over which we have no controul.

Light may be noticed 1st as Solar Light, 2nd as produced by combustion - 3rd as arising from

Chemical mixture. 4th as phosphorescent light, 5th as excited by circumst^e connected with the physiology of the human frame & 6th As reflected light from the Moon or Stars. First of Solar Light —

When the Sun rises the sensation of light is communicated to every living animal. Whence is this light? is the first question. Does it come directly from the Sun, or is it a substance preoccupying all space & brought into action by the Sun? Each of these has been supported by very respectable authorities. Against the first several difficulties have been advanced. Light never impinges against any body, however solid, & is never turned out of its rectilineal direction — proceeding invariably in straight lines: but if it come from the Sun how is it? — It can hardly be supposed, that it can strike a body without changing its direction. Observation & experim^ts show that it proceeds in an uninterrupted line. They say also that however small the particles of light may be they must create a waste of the Sun & also that every part of space must have long since been fully satu

rated with light. If it be constantly emitted. it must always be evident to us - whether the source of light be present or not - If a candle be extinguished - not only the light of the candle is extinguished - but all the light which is in a sphere of 4 miles in diameter - for a candle in a dark night can be seen at 2 miles distance - then, they say, it has been demonstrated from the eclipses of Jupiter's satel-lites - that light passes from the ~~earth~~ Sun to the earth, 93.000000 of miles in 8'-13" & a little more - ~~therefore the~~ whole sphere of which the Sun is the centre will be filled in the same time - then a ray of light is only 1/9th part of a minute in passing 20 000 miles - but it has been shown by D'Arcet that continuous vision exists for that time - continuous vision may then be kept up altho' particles of light are 20,000 miles distant from each other - They then argue, if a ray of light passes 93. millions of miles in 8' &c - then the whole sphere having the sun as a cen-tre will be illuminated & filled by particles in 8', 13", but the emission is without end, & in this case light would be concentrated in every part of the sphere

to a great degree, but when light is accumulated by a lens ~~to~~ 1000 times violent combustion then takes place. How is it, then that the World is not melted? —

These are the chief arguments against the idea of light proceeding from the Sun. How the properties of light are accounted for by the supposition that it is a fluid pervading all space, has been shown by Dr Young.

The objections against the second opinion of light that it was a fluid ~~a~~ preoccupying all space, are — that in other fluids — an undulation is produced in every direction by a resisting body — as in air & water — but this is not the case with light which always proceeds in straight lines — It is reflected & refracted in angular points not in curves — It never passes thro a crooked tube — while other mediums which are undulating as well as air in the transmission of sound. Rousseau has said many things wisely — many foolishly — a wise observation is recorded of him — "that a Philosopher should often say "J'ignore" — but never say "C'est impossible" The more we know — the more we find is unknown & the present question is still "sub judice," —

There appears to be a method of analysing light, not purely chemical. This is by the prism – which is a solid substance usually triangular & of glass. By it a solar ray of light is separated into other rays, each of which produces the sensation of a different colour; this is a uniform occurrence, not accidental or dependant on the glass: as all glass produces the same phenomena – These rays form the Solar Spectrum. They all possess different properties – even in a chemical point of view – The sensation of heat is different in the different colours – Dr Herschel ascertained that when the thermometer is in the red ray – a greater degree of heat is indicated than when in the violet – When Chlorine gas is exposed to the direct light of the Sun it is converted into muriatic acid gas – I say by losing oxygen, because light abstracts oxygen from other substances: if you precipitate ~~the~~ silver from its solution in Nitric Acid by the muriate of soda – you will have a white powder, expose part of it to the light – & it will become black

while the part not exposed will remain white, the action of the light ~~remains~~ removes the oxygen from the silver reducing it to its metallic state. This property of light varies in diff^t. parts of the spectrum being much greater in the violet than in the red ray. Therefore the different rays have a differ^t. affinity for oxygen. From these circumstances we infer that white light is composed of rays possessing diff^t. properties, as 1^st acting diff^y on the organs of vision. 2^nd they differ in affinities for oxygen & 3^rd in their affinities for Caloric. It has been ascertained that if the picture or painting of the solar spectrum be turned with considerable velocity the colours will disappear the whole appearing like a circle of white light. This would easily account for white light as the velocity of light is much greater than we can give to any body. As we see by means of light reflected from a body, it is manifest that a substance which could not be reflected or refracted could not communicate to us the sensation of sight. When a body decomposes a ray of light

reflecting the red ray & absorbing the other rays - the bo-
-dy will appear to be red - & will be so called - so also
of other colours. Hence every coloured body is a prism,
decomposing light - seperating those rays with which
it can combine & rejecting the remainder - It is evident
therefore that when all are absorbed the body will ap-
pear to be black - as Mr Saussure found that the
higher he ascended - the deeper was the blue colour of
the Sky; as there was nothing by which the rays of
light would have been reflected or refracted, there
would be no colour - that is would be black -
Where all the rays are reflected the body will be
~~black~~ white, & when only some of them are reflected
the body will be of ~~that~~ a particular colour -
Hence there is a chemical combination between par
ticular rays & particular bodies - because they re-
flect only some & must therefore have a stronger
affinity to those colours which are retained - Hence
in burning bodies - different coloured flames

are evident - So also when vegetables are growing they absorb & combine with certain rays - ~~&~~ reflec-ting the remainder which thus gives them a determi-nate colour - That this is the case, is proved by the fact, that when vegetables are tied up - the part so secluded from the light is of a white colour - That a chemical union takes place in these cases is evident from the fact - that the combination cannot be destroyed, unless the body is decomposed - If the diff^t - rays of the spectrum be collected in one spot - white light will be again formed; the rainbow is formed by the different refraction of the rays of light by the drops of rain - Hence a ray of white light consists of 7 colorific rays - of calorific & of deoxydizing rays. If the spectrum be divided into 360 equal parts - the red ray will occupy 45 of these, orange 27, yel-low 48, green 60, blue 60, indigo 40 - violet 80. These are permanent proportions of the diff^t rays - & therefore must depend on a permanent cause - & must arise from a permanent difference in the rays

themselves - If one of these rays pass thro' a hole, it will retain the same properties - If two pass, they will be mixed & form a compound colour - The violet is the most refrangible - the red the least - & the others are intermediate in degree - The middle rays of the spectrum possess the greatest illuminating powers - The calorific rays were first pointed out by Herschell who found that the thermometer rose higher ½ an inch beyond the red ray than it did in any part of the spectrum. Hence they have been called the colourless, invisible heat-making rays. The deoxydizing rays were first noticed by Scheele, who found, that mur. of silver was blackened 20' sooner in the violet than in the red ray. — Light is refracted best by metallic surfaces - hence in glass mirrors the light passes thro' till it comes to the metallic plate - & on this account it is easy to determine the thickness of a mirror, by placing a finger on the glass its thickness will be seen between the finger & the image, where it is thin we infer that the quality is by no means good. Light

are there not red flames. & blue flames &c?

is reflected from polished surfaces - of whatever colour - Glass coated with black sealing wax reflects but not to so great a degree as when of a lighter colour - but it softens very vivid landscapes &c for which purpose they are much used in Eng^d. — All transparent liquids of every colour look black when a black surface is behind. In Solar light calorific rays are always present in chemical combination - this is not the case in light from combustion or culinary light,

The light from the Moon contains no heat - this is owing to the size of the moon - & chiefly to the heat being absorbed,

Water reflects 8 out of 10 parts of solar heat —

Artificial or culinary heat is produced by the burning of a body. Heat united with the red ray puts on the appearance of fire - when with the white ray - flame is produced. Light is produced without heat by the combustion of phosphorus when very slowly conducted - so if phosphorus be dissolved in oil - & rubbed on the face & hands - a luminous appearance

will be seen without the face or hands being burnt.
When a candle is burnt - What is the process? No combustion can take place without the free access of air - none also without a Wick or combustible body - if the wick is thick - the outside only is burnt - the inner part having no access of oxygen is not burnt - but the tallow or oil is distilled off in the form of dense, black smoke - Hence twice as much is afforded by a pound of candles, 10 to a pound - than by one - having only four to the pound - The French patent lamp is founded on this principle - they reasoned in this way if tallow only burns as it combines with oxygen, it follows that the thinner the wick & the more exposed to the air - the more complete will be the combustion - Hence the economy of the Argand lamp - which is the best method of giving light - that either has been or shall be invented. The oil burnt is seldom pure containing mucilage - this being incombustible collects on the wick & renders frequent snuffing necessary.

The best method to clear oil is to wash it in diluted Sulphuric acid - with which it should be well agitated - this coagulates the mucilage - it should then be well agitated with powdered oak bark - suffered to subside & strained —

To measure the intensity of light - the best way by concentrating it by means of reflection - For instance let an Argand's lamp be placed on one end of a mantle piece & a number of candles on the other end; midway & somewhat anteriorly hold a clean glass bottle, or some similar reflector - the light from the lamp & that from the candles will thus be concentrated on opposite walls - & the intensity of the two be compared.

Light arises from some cases of chemical mixture - how this is we do not exactly know —

Phosphorescent light is emitted by vegetables in a semi putrescent state - also by fish when about to putrefy - The light frequently covering the ocean, is thought to be owing to some animal matter or to some shell fish - By filtering thro' a towel I have

frequently collected this matter but could not exactly determine its nature. Some of the precious stones are also phosphorescent - the diamond removed from a strong light will give out ~~the~~ light for a long time - hence it appears that bodies are really chemically saturated with light & supersaturated - so as again to emit it.

Light is produced by circumstances connected with the physiology of animals - Thus if a piece of silver be placed at the corner of the eye & a piece of zinc under the tongue, & a metallic connection be formed between them, a spark of light will be seen - If you press your eyeball a flash of light will be seen - so also if you receive a blow on the head - A man who has been hang'd & has been resuscitated - only remembers seeing a flash of light - he feels nothing.

Pharmaceutical Chymistry.

It is impossible to deliver a full course of lectures on Chymistry in less than 9 months - As I am limited to about 3 months I must therefore devote your time, to what is likely to be most beneficial to my auditors. With this view I proceed now to notice that part of our subject which relates to the preparation of medicines -

Of Materia Medica & Physiology - Chemistry bears no inconsiderable part - but by no means the most important part - When a body is organized it possesses some peculiar properties - as well as some chemical properties in common with other substances. Every animal & vegetable is an organized body: the particles are assimilated under peculiar laws, forming what I would term an organized crystallization - By crystallc is meant - the certain & definite form assumed by particles - when uninterrupted by circumstc. When an organizd body takes in by its organs - certain particles as food; these are digested & assimilated - not in a promiscuous form, but in

a particular direction & according to the laws of that body. – I take~~s~~ in a certain quantity of animal food – of vegetable food &c &c these are mixed with the liquids in my stomach duod^{m} &c – & out of them is formed one uniform chyle – this passes to the blood – which apparently is also one uniform fluid. Now – when the juices & soluble parts of the food are converted first into chyle & secondly into blood, they repair the waste of the body – when carried to the ~~[illegible]~~ brain – ~~are~~ organized & assimilated to repair its waste a ~~very~~ substance is formed very different from muscle – a different form is produced according to the previous organization of the part: as much so as crystallization in the mineral kingdom – If I break the claw of a crab – it will be renewed according to a form previously existing & not promiscuously – This is one property of an organiz^{d} body not to be explained by chymistry –

In all organic bodies – there is a principle of

life-existing with them - They have certain fibres which can be more ~~—~~ violently agitated by the application of stimulus - This capability of being excited is common to animals & vegetables, & is well enough termed Irritability - It is a property not to be explained by Chymistry —

There are other parts of animal substances, which, when excited do not produce the motions in which irritability consists - but a certain ~~set~~ motion is produced in a certain sett of organs exciting Sensation - This forms the Nervous System. It does not exist in Vegetables - the Berberry appears to be an exception, as when irritated in one part, motion is produced in a distant part - This is a single fact - & can lead to no general conclusion. This property of an animal is not to be explained by Chymistry —

When you place on a table a glass containing Acid - & a glass containing Potash - there they would remain in prison - "in statu quo" to the end of times When we mix them, they combine under circumstances which we know - & therefore we can predict the results

but in an organized body where everything is in a continual flux - where there is no particle which you can fix - I say - in such cases where the ground is moving under you - you can never predict with the same precision what will be the result - All the circumst^s modify the action of substances in such a way there is no arguing on the point - When however a substance is taken into the body it must have some effect - this it is our business to investigate ~~how~~ in what ever way modified - As chemical affinity is modified by the laws of organization, it is reasonable to infer that the laws of organizat^n are in some measure modified by the laws of Affinity acting on the particles composing the body - I will therefore briefly run over in the first place the chemical properti^s of the parts of the body so far as they are yet known -

Man is a vertebrous animal - he rests on bones - which therefore naturally first claim our attention -

It is now well ascertained that bone consists

x Phosphoric acid exists in the cerealia

chiefly of Phosphate of Lime. The lime is taken in almost all our food - & is therefore easily accounted for. The Phosp^c Acid exists in mineral subs^s of the oldest formation; we find the phos^e of lime in the form of a Green crystal, embedded in the [illegible] in this country - on the Schuylkill - about German^tn &c &c - As it therefore exists in the oldest minerals it is not * peculiarly produced by animal processes - but there is great difficulty in accounting for the whole, that is found in the body - very little, if any is taken in - with our food - there is more of it in tea, bread - butter - meat - salads, potatoes - a minute quantity is contained in the colouring matter of vegetables - but whence the body is supplied - is very uncertain, unless we adopt the supposition - that it is formed during the process of animal organization - It is not only found in the bones - but in large in several excretions, particularly in the urine - Bones contain 37 $\frac{u}{10}$ of phosphate of lime - 1 1/7 of posp^e of magnesia - 10 parts of carb^e of lime - a small quantity of

sulphate
~~phosphate~~ of lime - various proportions of gelatine
The Gelatine is procured by subjecting the bone to fire
the carbonates are dissipated - & the oil & fat are distil-
led off. In Ricketty children we find a deficien-
-cy - of bony matter, the bones remaining in the carti-
-laginous state - as in infancy - To ascertain what is
cartilage & what phosphate of lime - add to the bone
muriatic acid - this will dissolve all the phosphates - sul-
phates & carbon^c - but the cartilage being insoluble in it
will remain. Marrow is nearly the same as fat - con-
-taining a little more mucilage - I have in another
place detailed the use to which a dead horse is applied
in Eng^d. A dead horse is sold for 1/2 a guinea - The
skin is carried to the curriers - who pares it - presses out
the juices - removes the hair by lime & by several pro-
cesses already detailed makes it into leather - The
students of Comparative Anatomy then dissect it.
the flesh is sold in the city for cat's meat & dog's
meat - Sometimes the bones are carried to the ma-

-nufacturers of Cart-Grease about London - where they are first boiled to extract the fat - which is then boiled down with tar. Sometimes the bones are carried to the makers of Sal: Ammoniac - from them are procured the volatile liquor & an empyreumatic oil. The liquor is distilled off & suffered to stand in cylindrical vessel - after sometime it is drawn off by an opening in the middle so as to get it free from an oil which floats at the top - & one which falls to the bottom. This liquor is chiefly a solution of the Carb: Ammon^{a} - to it is added a quantity of common salt - & Plaster of paris - there is then a mixture of carb: ammon: - of mur: Sod: & of Sulph: Lime - The consequence of this is - that the sulphuric Acid quits the lime & unites with the Soda forming Sulphate of Soda - the muri^{c} acid - quits Soda - unites with the Lime & forms - Mur^{e}: of Lime. This is again decomposed by the carb: ammon^{a} - by which is formed a mur^{e}: of ammon^{a} & a carb^{e}: of lime - So that there are obtained - a Mur^{e}: of ammon: - a carb: of Lime - & a sulph^{e}: of Soda - Being set aside the Glauber Salt -

is the first which crystallizes & may be removed - the sal-ammoniac is then attained by further crystallization.
- When the bones are boiled for the purpose of making the Cart-Grease - they are not thrown away but they are ground - & used as a manure - In this way you may see that nothing is wasted in the Old Countries of Europe -

— Teeth - They have been said to contain fluate of Lime - I see no proof of this - they consist of bone & of enamel - which is finer than bone. Late experiments show that the enamel consists of 78 parts of phosph. of lime - & 6 parts of carb. lime - It contains no cartilage - In Acids - the enamel is soluble "in toto": bones are not - a cartilaginous matter remains - If a tooth be boiled in a solution of madder - the bony part will be coloured red - but the enamel will not - All the enamel is totally soluble in acids - & therefore dentifrices containing acids are injurious - To remove black spots on the teeth we may venture to touch them with Muriatic acid - taken care instantly to wash it away -

Nails - They consist chiefly of albumen not solu-

-ble in hot water -

Skin. This is composed of the Epidermis - rete mucosum - & cutis vera - The former may be seperated by maceration - & by vesicatory applications. Mr Belden on this account proposed to cure Corns by means of blisters - as these are formed of hardened cuticle, having their base exterior - & their apex pointing inwardly. I apprehend this will only answer in recent cases - The epidermis is not soluble in cold water - it is soluble in all the alkalies - It is tinged yellow by the Nitric Acid. If touched by ammonia it becomes of an orange colour - this is exactly the property of albumen. If albumen be suspended in a chimney - it will be converted into a yellow horned mass - cuticle is therefore like albumen -

There have been no sufficient experiments on the rete-mucosum - I believe it to consist of cellular membrane; containing a mucus fluid for lubrication it is the seat of the black colour in Africans. The cutis vera - is composed of interwoven fibres - soluble in hot water & therefore has no albumen but a large quantity of Gelatine - When Gelatine is extracted - there

is some fibrin remaining – but this is convertible into Gelatine.

Cartilages. These are convertible into Gelatine – no.

Muscles – When washed with water the fluid & colouring parts are removed – the water being changed to a red colour – & there remains a white substance – called Fibrin – How far muscle & nerve are the same – neither Chemistry ~~or~~ nor Anatomy has yet determined – When the colouring matter is washed away – you have part which coagulates – partly serum – & part which is more solid – The part which coagulates is albumen – the properties of which that it is soluble in cold water – but coagulable by hot water. There is another part seperable by alcohol – which is peculiar – Besides these there are portions of phosphate of soda – phosph: lime – carb: lime – with small quantities of phosp: ammon: potash &c –

Of the Brain – there is no useful analysis – alkalies dissolve the whole – part is soluble ~~in~~ in alcohol – it contains also the phosphates of soda & lime – If brain be

exposed to a strong solution of corros: subl: it will be hardened the soft parts being coagulated.

Hair. This is peculiar in containing sulphur - by itself - & as sulphurated hydrogen - besides this there are oil: manganese: phosphi: limes &c &c —

Bloodvessels - Glands - Of these there is no satisfactory analysis -

The Blood: If this stands - it seperates into 2 substances The Serum & Crassamentum - The serum contains gelatine, albumen - soda - it is somewhat acid alkaline changing litmus paper: it coagulates at 156° - it blackens silver, containing therefore sulphur - also there are carbo^e of Soda - carb^e & phosp^e of lime &c - The cruor or red particles are of the Spec: Grav^y of 1/4. ~~[illegible]~~ these can be washed leaving behind chiefly fibrin -

Urine. The serum of the blood appears on experi^t to possess rather alkalescent properties. I mentioned that I have doubts whether the phosphoric acid was not the produce of animal organization. The urine of all healthy persons is slightly acid - & when there is

indigestion it is uniformly more acid. Now if the Serum be alkalescent & the urine secreted from the blood be acid - How is it? unless a change is effected as it is acted on by the animal substances - In books it is stated that the serum is alkalescent in a healthy state - this I have no reason to doubt. That the urine is acid I know from an hundred trials. It is then clear that during the secretion of urine that an acid is formed where an alkali previously existed - What acid is this? According to Thenard - there is a quantity of Acetic acid, - Berzelius says that there is a small quantity of the Benzoic Acid. The chief acids how-ever are the Phosphoric & Lithic Acids: almost all the salts are Phosphates - but whence come these? we find phos^e lime, soda - & ammon^a Lithic acid un-combined & ~~mixd~~ also in combin^n with lime, am-monia. I do not know how these acids get into the urine - as far as our knowledge goes our nu-triment contains very little of any of them - the pro

-bability is that they are the product of animaliz a-tion- Ammonia will precipitate phosph.^e of lime & magnesia- also album.^n & Gelatine- If inspissa.^d cooled & crystallized- & if the crystals be dissolved in Alcohol you will have a saline substance- Urea which will comprise 7/10^ths of the whole- That urine contains Phosph.^c Acid is well known- as from it Phosphorus was formerly obtained- This was done by adding acetite of lead to urine- this united with the Phosp.^c & Uric Acids- This last was then driven off by heat- the phosp.^t of lead remaining- by distillation with charcoal- the lead was revived-
There is in urine, also acetic- muri.^c & Benzoic Acids, phosp.^e ~~lime~~ & Urates of lime, ammonia & soda-
The soda is obtain.^d from the salt which we eat- & the ammonia- from our animal food-
When digestion is impaired there is a preternatural quantity of acid in the stomach- in such cases it is not probable that the serum of the blood is alka

-lescent. Temporary relief is afforded by warm sti-
mulating drinks - Magnesia is a better remedy - Stone
is to be imparted by a change of life - by animal
diet - exercise, warm clothing &c - The quantity of
acid in the urine is in proportⁿ to the acid juices in the
stomach - but where the tone of this organ has been weak-
-ened by intemperance - if any acid urine or acescent
matter be taken into it - it will not possess the power
of changing it into an alkali - but acid properties
will be imparted to all the secret^s - the sweat & u-
-rine will each redden litmus paper - In cases of
dyspepsia then, there is an increase of acid in the urine
generally of the phosp^c & Lithic Acids. This in young
persons will produce the stone & in old persons the
Gout - These are in reality the same disease there
is no difference in their cause - & vary only accor-
-ding to the constitution which is attacked -
What is the Stone? It is an accumulation of
Lithic Acid - lime - Phosp^t Lime - Mag^a - &c &

united in layers by albumen & gelatine. All nephri-
-tic complaints generate urea - & Lithic Acid - Now
in Gout, concretions are formed in the joints & extremis
which on analysis are found in every case to consist
of Lithate Soda - The causes therefore are the same - the
concretions are not only apparently - but also chemical-
-ly the same - & it is utterly impossible that they are not the
same disease differing only as to the parts affected -

Previously to the time of Hoffman, all physicians
accounted for ~~the~~ disease - & for the operation of medicines
by the effect produced on the fluids - which were thought
to be changed by disease - & could again be changed by
medicine - but Hoffman finding that medic. had pe-
-culiar propert. - thought that the fluids were under
the control of the solids - & that medic. acted on the so-
-lids - This idea was adopted by Cullen - & is now
the prevailing sentiment - It is in some measure
true - but has been carried much too far - It would
be well for its advocates to consider, whether the che-
-mical properties of the fluids are absolutely unwor-

thy of notice - when it is a fact that all the solids are formed out of these fluids - I believe that there is no demonstration in Euclid more clear than that the gout & stone depend on the nature of the fluids. I can give myself the Gout to a certainty - by drinking acid wine my urine will become acid - & my sweat will be acid - If I take magnesia - my urine & my perspiration will become alkalescent - How is this? How is the urine rendered alkaline by an alkali taken into the stomach. Would it not be neutralized - & destroyed before it can reach the bladder -? I frankly confess I know not how it is - nor can I explain it - but it nevertheless is a matter of fact -

Calculi are found in the Gall Bladder & in its ducts - In books these are said to be of an adipose, waxy substance & no doubt are truly characterized. There are two modes of getting rid of these by stimulating the liver & its ducts with the Gall bladder by mercury - & by chemical means. Where their presence is productive of great pain, immediate ease is obtained by bathing the feet in warm water.

Bile is a smooth, soapy - perhaps alkalescent fluid, poured out in varying quantities into the duodenum - it is changed to a green colour by vitriolic Acid - & by other acids - Hence from acid in the stomach it is often vomited of this dark green colour - Formerly I sometimes painted a little - & for this purpose procured gall stones which gave me the finest yellow that I could get - I never applied to a butcher in Eng^d but what he would furnish me with two or three of them - In this country I have never been able to procure a single gall stone from a butcher - altho' I have very frequently applied for them - What is the reason of this difference in the animals of the two countr^s?

Four out of five parts of a stone in the bladder consists of urates - often several phosphates - their character is usually owing to the Lithic Acid - This is not found in our food - & must therefore be the product of animalization - There are certain states of the body in which cal:^l is a pleasant & mild purgative - In those cases where the patient is troubled with acid on the sto-

-mach- or with Hemorrhoids which last I believe owing to a morbid acid in the primæ viæ; cal:^d will produce violent tormina - the acet^e of mercury will not produce these effects - but the phosp^e of mercury always acts very violently. It has often occurred to me, whether the tormina produced by the calomel was not owing to the presence of phosphoric acid - This is however a conjecture only. —

To ascertain the quantity of Urea - in a given quantity of urine - inspissate it & dissolve it in four times its weight of alcohol: If nitric acid be added the urates will be changed to a Pink colour - The phosphates may be separated by heat from the Urates in which the latter will be dissipated.

Albumen This is a common animal substance it is miscible with cold water & coagulated by hot water; it is the scum which rises in making broths - & which is thrown away -

Gelatine - is miscible in cold - & soluble in boiling water - It is precipitated by Tannin in the form of leather. —

Mucilage - or extractive matter. This is distinguished from albumen in not being coagulated by hot water - & from gelatine in not being precipitated by tannin. ——

Fibrin - is not soluble in cold water - but is by long digestion in hot water - it is similar to the gluten of wheat. Fibrin contains small quantity of Nitrogen not found in Gluten - —— I do not know that any medical fact can be deduced from all that I have said but there is every reason to believe, that ~~will~~ they will find their place in a chain of facts - leading to import^t conclusions

Dr Bostock by corros: sub: & acet: lead attempted to distinguish pus from other morbid secret^n. Later experiments have not confirmed his opinions - & a surgeon's eye will answer his purpose without any resort to Chemistry ——

Having thus briefly noticed the chemical history of the animal body - I proceed to the consideration of those substances which are employed as ~~[illegible]~~ medicines & which have more or less influence on this body -

The first which I shall notice shall be the simple articles & then proceed to those which are more complex.

Potash. This is not much used in its pure state, perhaps in no case — unless it be in calculous affections. From time immemorial it has been known to alleviate the symptoms of stone — Dr Hales — in some miscellaneous exper^ts first threw light on this subject — He took a stone & boiled it in an equal weight of caustic potash — & found that it was nearly dissolved. The solution in the carb: of potash was not so great. Forty years after — Dr C   an empiric propos'd a remedy which he would not sell in substance, but mixed with soap. This was ascertained to be the caust: potash; it was much employed until it was used so empirically that serious injury was produced — Some time afterwards a Mrs Stevens proposed a remedy for these complaints. Which I believe was in reality of great efficacy, notwithstanding the subsequent experiments of Brande

which I believe do not deserve the confidence generally reposed in them — It is utterly impossible to have the testimony of more respectable persons for to the efficacy of any remedy than that which was given for the remedy of Mrs Stevens. In a work by a Mr Dodsley, (not often medically read) there is an incidental mention of the efficacy of oyster shells & pure potash in calculous complaints. Mr Hey in a tract on deformity bears a similar testimony. As to Mrs Stevens' remedy with castile soap — the quantity taken is very safe — ℨi — of good Castle Soap, a day has, no ill effect on digestion & an excellent effect on the gouty symptoms. I myself have taken ℨß daily. & I have therefore no doubt of the good done by the remedy of Mrs S. You cannot give the same quantity of pure potash in any other form — there is in castile soap 1/8th part potash — so that in every ℨß — there is ℨß of potash — in the usual way of exhibiting the alkali in soda waters — you cannot give more than

1/4 this quantity - But according to the experi^t of Mr Brande the alkalies have not the effect usually ascribed to them - I am however sure - that if exhibited in sufficient quantities they _would_ & that they act upon all stones & calculous matter in the bladder - It is argued that it is impossible - that the alkalies can get into the bladder - how it gets there I know not but I do know it _does get_ there - Fourcroy attempted to inject the alkalies into the bladder - but this gave too much pain - The alkalies are useful in jaundice - jaundice can be ascertained chemically - by adding strong muriatic acid to the urine, by which a green colour will be formed - The urine is very much affected by disease - so that some have pretended to tell all diseases & to point out the cure from the state of this fluid - In nephritis - in calculous & gouty cases, there is always a lateritious sediment - Corr: sublimate added ~~added~~ to urine of healthy person produces no change - but where there

is high inflam^y action - a milkiness arises from the mixture - in jaundice a green colour - & Nitric acid also causes a milkiness in the urine of a dropsical person but ~~ha~~ has no effect on healthy urine - These facts are worth knowing - - Potash is used in no other disease - Combined with Sulphuric Acid - It forms the Sulp: of Pot: the sal Polychrest - This is not so good as other cathartics - It is now out of use - being the refuse of the manufact^e of oil of vitriol it is employed to adulterate pearl-ash - The Nit: of Potash - is a good febrifuge & diuretic article - combined with antimony it is given as a diaphoretic - when no diuretic effect is wanted -

Soda - Pure soda is not used as I know of - the Sub: carbon: is used in the form of Soda pills in nephritic complaints - but the patient cannot take enough of it. The best form of taking it is to take of the efflorescced salt - perfectly dry - & mix it in as large quantities as possible with a solution of soap. Of which as much is to be taken, as the patient can swallow - ~~Alcohol~~ Given in Seltzer water gan

cannot take enough - - The Sulph^e Soda is the re-
fuse of so many manufactures - that it is very cheap - & is there
fore much employed - It is a good cathartic - but is very
nauseous - this is best covered by lemonade - But of all
the cathartic salts - the mildest the pleasantest & the most
efficacious is the Phosp^t of Soda - It is made by adding
no. the phosp^c acid to common salt - the dose is ℥iss - Inst^s.
have occurred in which it exacerbates hemorrhoidal symp-
-toms - in which cases I would be as cautious of its use as
of aloes - neither would I use it when mercury is given - as
it - I suspect, will form a phosph^e of mercury - producing
great pain & tormina in the bowels - I have not had
sufficient experience to decide this point ———

The alkaline Sulphurets - Rollo has given them
in doses of grs. xx. in diabetes - This is a mere farce
grs. xx. can have no effect - all English practice is on
much too low a tone. In diabetes - all our practice
is very empirical - vegetables & acescent matters do
harm - alkalies & animal food should be employed.
The Sulphurets are useful in cases of mineral poi-

sons – the sulphurets of metals being inert where the oxides are active. Hence the sulph^t of potash & soda should be exhibited when any of the mineral poisons are taken; as possibly they may unite with the metal & render it inert.

Ammonia – is the best stimulant we possess – it is not so strong as Ether – but is better & more lasting; especially in disordered digestion – & in Hysteritis – which last I believe in many cases is a disease of the stomach – Why indigestⁿ should produce flatulency I know not – but the Globus Hystericus is entirely owing to flatulency, arising from disordered digestion. The best remedies are warm brandy with plenty of good spices – &c &c — The muri: amᵃ is the comⁿ sal ammoⁿ used externally in bruizes &c – the carb:ᵉ is gen^y used – the caust^c amᵃ is both a good stimulant & a good antacid ——

The Acetate of Ammonia is used as a diaphoretic –
The Nitrate is used only to procure the Nitrous Oxide.

The Earths. Lime – When an alkali is given in a dyspeptic case, it acts merely as antacid – having

as I believe, no other effect - when lime is given it acts not only as an antacid but also as a tonic - Dyspepsia has been cured by it alone - a pint of the water being given daily. In this way not much lime is given, as it is but sparingly soluble in water - It must therefore be peculiarly stimulant to the animal body, as it is to vegetable substances - Lime stone applied to a vegetable produces no effect - but the lime itself proves very stimulant - It is so nauseous that it seldom can be given. The carbonate of lime - which is the common whiting or prepared chalk is in many cases a good substitute; in doses of ℈ij it proves antacid - but does not act as a stimulus - as the pure lime - The Sulphate of lime Gypsum or Plaster of Paris is not used in medicine It is a good stimulus to vegetables - but there is no arguing - that it would therefore prove so to animals - Muriate of lime has been given in Scrophula - but to no purpose. —

<u>Barytes</u>. The muriate only has been employed - to my knowledge it is of no service in Scrophula, in

which it has been employed very extensively. The first public intimation of the poisonous effects of the carbonate of Barytes was given by me, in a letter addressed to Mr W—— of Birmingham. In numerous experiments made by that gentleman & myself on dogs we found that almost invariably grs. xv. proved deleterious & that a much larger dose was fetal. Hence as our best remedies are taken from poisonous articles, may this not prove serviceable as a Medicine?

The Gases. Nitrogen gas has never been given as a medicine.—

Oxygen Gas. This has I believe, been given by one Physician only, Dr Thornton whose experiments have not been confirmed. If oxygen is a stimulus to a candle, it must be so to animal life. At Carlisle I once breathed 6 quarts of this gas in the morng. & in the afternoon I breathed the same quantity. The consequence of this was that I was threatened with apoplexy, had a violent determination of blood to my head with pain & vertigo. I was bled & took a cathartic, next morn-

-ing I was well - having had all the symptoms of plethora & inflam. diathesis. I have no doubt that it would prove a valuable remedy in Typhus & other low states of the system. It is impossible not to believe - that oxygen - which enlivens combustion - must also prove a stimulus in a debilitated state of the body - & the reason, why it has not been more employed in this country is, that physicians are not Chemists - & there is no one to prepare these articles for them -

Hydrogen gas - has been employed in Phthisis only -

In the year 1794 - Beddoes published his work on this disease - He from the bright colour of the lips - the hectic flush - of the countenance - & the morbid lustre of the eye supposed that this disease consisted in a supr. oxygenation of the blood. Agreeably to this theory he concluded that a cure might be effected by articles which would lessen the quantity of oxygen - A sister of Dr Priestly was put under his care, she had all the symptoms of consumption well marked - She & another lady in a similar condition were placed in a cow-stable

Her companion soon becoming tired left it in a few weeks & not long afterwards died — Dr P—'s sister remained for 3 or 4 months as required — & was finally dismissed with all her symptoms dissipated. She continued well for about 12 months — when the disease returned & she died — Mr W— of Birmingham upon the same principle exhibited Hydrogen to his daughter in consumption; He administered 1/4 hydrog to 3/4 ths common air; & always with an evident palliation of the symptoms — She however died.

x It has been tried in many other cases, it palliates but it never cures.

Carbonic Acid. This gas is never given as a medicine. When breathed it produces a violent oppression & almost instant suffocation, the person falling down as if dead — If fresh, pure air is soon administered they often recover —

The Nitrous oxide gas — This is well known, as a powerful stimulant — It has the peculiarity of never being followed by the debility succeeding the use

of other stimulants. I presume that the exhibition of oxygen & of nitrous oxide to be clearly indicated in all typhoid cases & likely to prove very beneficial. The French Physicians have given Phosphorus in such cases. This is the strongest stimulant we possess - ½ gr. is rubbed up with honey. this produces a violent heat & all the effects of the strongest stimuli. It has not been much used in this country. I have prepared for a physician in Northumberland who exhibited it to a patient who was in the last stage of Typhus. it did not save him.

Sulphuretted Hydrogen. Springs impregnated with this gas are universally resorted to. They are to be found near York & Carlisle in this State & also in Virginia. They are very nauseous & very how disagreeable I believe that they are of no use whatever, & that the circumstances attending excursions to watering places accomplish all the cure.

The Acids. Sulphuric Acid - this is said to be a tonic & it may be so - but I have never seen any tonic effect produced by it - we have much better tonics.

Nitric Acid. This was introduced as a cure for the venerial by a man who thought himself a good chemist — His supposition was that as this acid parts with its oxygen very easily it would cure syphilis; wisely concluding that it was the oxygen that ~~was~~ effectual in the preparations of mercury because the metal itself is inert. It is not the oxygen of the mercurial preparatn that does good, as we find that those which contain the most oxygen are least effectual — & consequently Nitric Acid is of no service — it never cured syphilis. It may assist mercury — as all the acids render every form of mercury more active — When taken in cases of debilitated stomachs ~~the~~ caution should be used — as there is danger of acting on the ~~stomach~~ teeth — I have known a beautiful sett of teeth entirely destroyed by it.

The Arsenic Acid is never used in medicine —

The Citric Acid — The common effervescing mixture is a pleasant laxative usually prescribed where there is an irritable state of the stomach. In exhibiting it care should be taken to exhibit it during the act of effervescence as otherwise much of its virtue is lost —

The citric acid is superior to the Acid of Tamarinds — The Sulphate of Potash — is a purgative not now much used.

The Arseniate of Potash. This is Fowler's celebrated remedy for intermittents &c — & is prepared by boiling grs. ~~6~~ x 10. of Potash with an equal quantity of arsenic in a pint of water, till the whole be dissolved — After which ~~the~~ some Spt of Lavender is to be added, till the pint is filled — There is no tonic, so effectual, I have no doubt that it is superior to the bark. In the year 1802 or — 3 — I was in the county of Lycoming where upwards of 2/3rds of the inhabitants had the fever (intermit't) — in one or two cases I gave this medicine — a cure was effected by 2 or 3 doses. It soon became very popular & I was obliged to renew my pint measure every day so great was the demand for it — & I never knew or heard of a single case in which it failed. The Bark when good & given in sufficient quantity is an excellent remedy — But is a very expensive one & moreover is not as effectual as Fowler's Solution. I usu-

-ally begin with gtts. vj twice a day & encrease to biij or x gtts. You may venture to give it till nausea is produced when you should diminish the dose, as this will always be too great- when nausea follows its exhibition it causes indirect debility- thus counteracting itself. It should therefore be given in the largest dose without exciting nausea.

The Phosphate of Soda is the best - the best tasted & the most pleasant of all the cathartics. It is contraindicated where there are piles & where mercury has been given as in these cases likely to produce violent tormina.

The Tartrates. All of these are bad as they are likely to increase the Uric Acid. The Super Tartrate of Potash has been much in vogue as a diuretic. Ferriar has published numerous cases of its successful employment. His cases are gen^ly well related & some of them which I attended with Dr Ferriar I know are truly related - This medicine however loses its effect & should be alternated with digitalis. Digitalis should not however be given to old debilitated persons. Cal^l & squills are good - Elaterium is however the best remedy

for dropsy. It is much used in Europe but not at all in this country. Ferriar at the close of his work tells us honestly, that we should recur to elaterium, if the other remedies fail: It is an article of great power sometimes producing violent tormina of the bowels, vomiting & even disease of the bladder: but when judiciously used, it is an admirable remedy. A quarter of a grain is the dose to begin with. Of all the evacuants of water it is the best, surest, & most permanent.

The Mur: Ammonia is used externally as a stimulant embrocation: ℥j being dissolved in a quart of vinegar.

<u>Magnesia</u> — The carb: has less taste than the pure magnesia. I have often calcined it & found that grs. xx always loses grs. vij. The calcined mag.ª is more nauseous but mixes better with liquids. In all cases of impaired digestion mag.ª is the remedy — it should be given in large doses: Three tea spoonfuls often removes the symptoms like a charm — when it meets with

acids it purges, otherwise it has very little action on the bowels - thus it purges only where a cathartic effect is desirable. Diarrhœa, Dysentery - Piles - originate from Dyspepsia - In hemorrhoids gentle purgatives should be employed - magnesia is the best remedy. As a good laxative in these cases the following is much used - Take equal weights - of crem: tart: Sugar & sulphur & when duly mixed, it proves a certain & pleasant laxative - Magnesia according to Brande is a specific for the gout & the stone when exhibited early. In my own case subject to gouty attacks, I alternate it with castile soap: generally premising a cathartic - as the gout is usually ushered in by several premonitory signs.

Alum is a bad remedy in Dysentery; all astringents are not however bad, I have cases cured by the ext: of catechu.

Barytes - has been employed to cure Scrophula, I have often made the muriate for Ferriar in these cases - but it was never of any service.

Phosphorus - I have already noticed this as having been

given in Syrup rubbed up with honey. It is also given in Ether & Alcohol – but the best way I suspect is to mix it with olive oil: with which it should be gradually & well ground. I believe it can be given this way with more safety & with more efficacy as it is then more gradually decomposed – so much so that it can be rubbed on the face & hands without burning them.

Sulphur. Is given to cure the Itch. This disease I believe to be owing to the formation of animalculæ in the lymphatic system – to cure it, Sulphur is generally used. There has been a great dispute about cutaneous absorption. I know that when sulphur is rub'd on a part, having the itch – it effects a cure – also when mercury is rubbed on the inside of the thighs – the money & silver in the frock it will be blackened. I do not know whether mercury has ever been detected in the circulation – the experiment of Dr Massey on cutaneous absorption is I think perfectly decisive – he immersed himself in a bath of rhubarb – & in two or three hours his urine was tinged with the rhubarb; this settles the point. That sulphur appears in the excretion by sweat – I am also pretty well satisfied – some

years ago I had an attack of hemorrhoids - I took the purge already mentioned of crem: tart; sulph: & sugar - In a short time I found that my watch was blackened. How was this? — Sulphur is a dirty unpleasant medicine - the best remedy for Psora is the Ungᵐ: Citrinum; so called from its colour: it is made by taking the nitrate of mercury dried & rubbing it up with the Ungᵗ Simp: It never fails in effecting a cure —

The Metals. Gold. Has been employed to cure Syphilis & Epilepsy - but to no purpose —

Silver. This has been highly recommended in Epilepsy: in some cases it has afforded some relief, in others it has failed - If we prescribe at random without any principle to go upon; we may or we may not succeed. How can Silver cure Epilepsy? It must be by its tonic powers only - & it is certainly inferior to arsenic as a tonic —

Mercury. This is the reign of mercury - when every thing else fails, we resort to this article: & I believe very properly - It was employed about 1740 to the year 1750 in a metallic state - with the view of removing

obstructions by its weight. It was of no service [illegible],
In Wesley's old book I remember there is a prescription
for worms which I took when a child & which cured
me - it consisted in boiling ℥i. of mercury in a pint
of water - all the efficacy of this must arise from a portion
of the mercury being acted on by some of the salts in the water.
Plenk's pill is mercury in the first state of oxidation; it
is a protoxide - ~~it is a protoxide~~ - & its action must de-
-pend on acids it meets with in the primæ viæ.
"The oxide first used was the precipitate "per se." In
preparing this mercury was in a broad glass vessel having
a long neck ~~at~~ somewhat twisted - this was exposed for
about 8 days to a regular heat - by which it was converted into ~~in~~ a brown,
dull, red powder; the object of the long-twisted neck
is to prevent the ~~too~~ sudden evaporation of the mercu-
ry - at the same time that an ingress is allowed for
the atmospheric air. This is a true oxide of mer-
cury - & by a higher degree of heat - it is decomposed &
the mercury is revived. - The common red-oxide or
red precipitate is prepared by dissolving mercury in

Nitric Acid, evaporating it to dryness & then heating it in an iron ladle till the red fumes have passed over. At first this preparation is of a dull red colour - but it becomes sparkling by exposure to the air - it is no respect superior to the precipitate "per se" - & is often adulterated with red lead - which could not be done with the other — The precipitate per se is more uniform in its action than the other; in doses of gr. ss. twice a day it uniformly salivates & seldom purges. The red precipitate by Nitric Acid is not exhibited internally at present - but is employed externally as a stimulant or as an escharotic application.

The Sulphate of Mercury is not out of use - the Turpeth is a very harsh emetic.

The Muriate of Mercury, This is of two kinds - the submuriate & oxymuriate - If lbs. ii. of oil of vitriol be added to an equal weight of mercury - & reduced to a dry mass by boiling - a white powder will be obtained which if thrown into boiling water forms the turpeth mineral - When however the white powder is added to

× on the contrary, the white precipitate will be thrown down.

the muriate of Soda - & heat is applied to the mixture the Sulph^c Acid unites with the Soda - & the muriatic to the mercury, forming a muri^e of merc^y - this by a continuation of the heat is sublimed - it is the corros: sublim^e of the Shops. If a portion of corros: subli: be mixed with an equal quantity of mercury - triturated & sublimed - calomel is obtained - this should be well washed & ~~redistilled~~ resublimed, & should finally be again washed & finely levigated. The corros: sub: is an oxymur^e of merc^y: & may be distinguished from cal^l in this way - If pure ammonia be added to corros: sub^e no change of colour is evident - when it is added to calomel - the mixture assumes a black colour.[‡] Both of these preparations are much used - the corros: sublimate is much confined to the cases of Syphilis: externally it is very useful. If grs. xx. of corros: subli: be dissolved in of brandy - and be applied to a recent chancre - the whole will be turned out from the sound parts. Pringle has dissolved grs. viij in a

+ Calomel will be ~~precip^d~~ decomposed - ‡ which is the black Ox^d of mercury

pint of brandy - of which ℥j was given as a dose so that salivation was induced in four or five days. It is said - that this practice does not effect an absolute cure - but merely moderates the symptoms. Corros: Subl^e is an excellent poison for vermin - especially the common bed bug. grs. xxv - being dissolved in a p^t of Whiskey - being rubbed over the bed-stead not only destroys them at the time, but prevents the appearance of future visitors - Calomel is the mild sub: mur: of mercury - It is sometimes apt to excite nausea & often remains on the stomach for a long time inactive. As an anthelmintic it should be given in small doses, so as not to operate too speedily - but to remain in the bowels, that it may poison the worms - a strong purge should then be exhibited to bring them away - Calomel is the best remedy for the botts in horses - Larger doses may be exhibited to these animals in proportion to their bulk than to a man. Speaking of worms - I may observe - that Dr

× Yes it is used: it forms Keyser's pills.

Bittroma has exhibited the oil of turpentine in cases of worms - especially of the tænia - This I have no doubt is an excellent remedy in all cases of worms - as no insect lives in this oil - Mercury however is superior to every other - ——

The Acetate of Mercury is not used - but I think ought to be - the red precipitate dissolved in distilled vinegar forms a good external preparation - but is too nauseous for internal exhibition.

Phosphate of Mercury. This is a very drastic purgative - & is not much used —— Mercury is very much exhibited in all bilious complaints - & in fact in all cases where a general stimulant is requir.d & as I think with propriety. When incautiously administered - a peculiar disease is induced - which is called the mercurial fever. In all cases when given in too large a quantity there is a stoppage of its good effects, & debility & mischief is produced - When the fever has come on the mercury should be immediately laid aside - it can do no good, till all the inflam.y symptoms

are removed. In prescribing this medicine its effects should be carefully watched - the instant there is a metallic taste in the mouth & a soreness of the gums it should be discontinued - if carried beyond this point - it will produce indirect debility - destroying its tonic effects it will do harm.

<u>Copper</u>. This metal is exhibited as an emetic - Mr of Birmingham has been famous for his dry vomit - which consisted of grs iij or iv of verdigrise - with which he allowed no drink to be taken - he succeeded by practicing boldly - The English Physicians in general understand diseases well - but their practice is timid - When the common emetics fail - we come to Zinc or Copper - In the year 1798 - I had an attack of the Croup - grs. iv of tartar emetic was given to me, it had no effect in one hour - a kind of hydrophobia came upon me - either from ~~reality~~ real disease or from the effect of imagination I was seized with tremors & could not bear to touch any fluid - 4 more grs. of tartar emetic was exhibited but ineffectually - 4 grs. of verdigrise were then

administered - vomiting came on & I was immediately cured. Lettsom says that no one recovers from Croup without bleeding. I have never known one cured by bleeding. Many years ago while in Engd my son had an attack of croup - Dr Ferriar attended him. Emetics of every kind were given to him - but with no effect - the disease rapidly progressed - & became very violent - The Dr came to me & informed me that my child could not live, more than one hour. I then resolved upon the following experiment - I took some hot water - on the surface of which I poured some æther - the fumes arising from this I made him breathe by closing his nostrils - & directing the vapour towards the mouth - This induced suffocation - the abdominal muscles were thrown into action - & the emetics formerly taken, now operated freely - He recovered. This is a fact worthy of your remembrance. In all cases, if you produce full vomiting - your patient is safe - at least I have never seen or heard of a case to the contrary - Copper - in the form of

Cuprum Ammoniacum is an excellent tonic. — If you grind the crystals of verdigrise & spread the fine powder over the surface of a recent chancre where there is little inflam.n & where no fluids are formed so that absorption may have taken place a cure will be effected in two or three days. If absorption has taken place, mercury is the only remedy. When persons are poisoned by copper you can detect it in the matter vomited by 3 methods — First add an acid — after which if you dip the point of your knife into the fluid the copper will be precipitated on it: secondly if you add ammon.a a blue colour will be produced — or thirdly add Fowler's drop & you will have a green colour.

Iron. There are only two cases in which it is given as a Tonic & as an Antacid — It is much used in Dyspepsia & Chlorosis. As a general rule all metals are tonics in moderate doses — when given in excess they are injurious & poisonous. The proper dose to obtain the tonic effects — we must learn from experi-

-ence. Iron with sulphuric Acid forms the green vitriol or sal martis of the old Chemists. This is the best tonic we possess from this metal - it is given in doses of grs. iij, iv, or v. The Nitrate of Iron is never given & yet it is likely to be one of the most efficacious - as the iron is much more oxygenated & a less dose will answer — The Muriate of iron is used in the preparat^n^ of Tinc^t^ Flor: Martial:. The Flores Marticales are ~~used~~ made by subliming iron with sal ammoniac. There are many cases in which the same indications are fulfilled by two remedies - exhibited separately but which have no effect when combined. For instance a tonic is wanted - the D^n^ of bark - the D^n^ of Kino - or any of the bitter I^ns^ may be usefully given - so also the T^r^ of the Flores Martial^s^ is very good. But if you were to mix this last with any of the others - you destroy their tonic powers - an ink is formed possessing different properties from either of the others.

The Carbonate or rust of iron is frequently administered in doses from grs. v to xx. At one time the crocus martis was much employed - the red oxide formerly

-ly mentioned is better than any of them - These are render'd active from combining with acid in the primæ viæ it is useful to alternate them with the bark - but they should not be given together for the reason already assigned. The iron filings are very advantageous in chlorotic & dyspeptic cases & I suspect are superior to any of the oxides.

Lead - The Nitrate is used only in Psora - Tetters &c - I have been informed by a friend of mine who is one of our first Chemists & an excellent practitioner that he has never failed in curing Tetter by applying the juice found at the bottom of pots, containing the rolled tobacco - it should be diluted previous to its application & it will always succeed. In one case of a student at Carlisle I applied the tobacco juice, & have every reason to believe, that it effected a cure I ~~heard~~ saw nothing more of it. The Acetate of lead is much used by Calico printers in fixing their colours Sugar of lead - & alum added in equal quantities to each other - forms the Sulph. of lead - the acetic acid unites

with the alumina forming the acet^e of alumina, which remains in solution — In medicine the Acetate of lead is only used to stop hemorrhages: its ~~exhibition~~ influence in all kinds of hemorrhage whether the system is excited or depressed appears very powerful. The dose is gr. ij every hour - to be increased, till the effect is produced. This has been considered as a dangerous article - but I do not know, that paralysis has ever been produced by the sugar when exhibited medicinally. The Derbyshire colic has been produced by using vessels, the glazing of which contained lead. Painters are subject to Paralysis - in the white lead works - the workmen seldom live longer than three years; but notwithstanding these facts I know of no case of paralysis caused by the exhibition of lead in medicine. I believe that it is not employed to fulfil any other indication - it would answer as a tonic - but it has not been given —

Tin. This is given in cases of worms in the form of filings - upon the supposition of its acting mechanically - It may be good - but I have never tried it - it is

an inelegant preparation at least. All worms are killed by Mercury if you make them hungry —

It is a law of nature, that where one organic body is in perfect health - it is never preyed upon by another: but where there is an organic body that is debilitated it there becomes the prey of other organic beings. This applies to vegetables as well as to animals - hence we see old Oaks &c supporting the mistletoe - hence also children are afflicted with worms which never trouble the healthy adult - whose bowels are no ways debilitated. Wherever there is debility - there is always a parasite prey on them & where the life of the parasite possesses more energy than the organic body on which it feeds - the latter will be overcome & enfeebled - The indication there fore is ~~how~~ to restore the strength of the system by tonics, as the most effectual way of relieving it - of these animals. - The Limatura Stanni are supposed to kill the worms mechanically - this I do not believe, but think that the tin is acted on by the acids in the stomach.

Zinc - The Sulphate of Zinc is employed as an

emetic - it is not equal to Copper in this respect as it is not so certain in its operation. No danger is incurred by using copper in this way, as the whole is fully evacuated. Formerly persons were poisoned by using copper vessels in their culinary processes - it is a singular fact that the vegetable acids - while boiling never act on the copper - unless at the very surface where it is exposed to the air. Zinc then is of no great value as ~~an~~ emetic - but it is very useful ~~as an eye water~~ in certain diseases of the eye - When the sulphate is employed - it is likely to do harm - the sulphuric acid has a bad effect on the eye - This I have seen frequently - The best collyrium is prepared by mixing equal quantities of Sulpht^e of zinc & sugar of lead, together - an acet^e of zinc is thus formed which remains in solution & is the mildest collyrium I know of - When diluted with rose water so as to be slightly astringent to the taste, it is very useful & excellent. Zinc is also used as an injection in Gonorrhea. This - I believe, at first to be a local disease - not the case however after 2 or 3 days - Unless the

injection is mild you run the hazard of inducing stric-
-ture - which are always troublesome for life. Injectio
in Gonorrh.a should always be combined with opiates, &
I prefer the solut.n of the Acet: of Zinc, ~~as above~~ of half
the strength above directed for a collyrium. Remember
however that where there is time for the matter to be ab-
-sorbed you must give mercury - This should not be
carried too far - otherwise you lose its tonic effects &
induce a mercurial fever which is the worst of all
fevers -

Antimony. The regulus of antimony was first used, as
in making the perpetual emetic pills. All the prepara-
tions of antimony are now superceded by the tartar emetic.
The tartrite of antimony is best made by the direct com-
bination of tartaric Acid & glass of antimony, or by
precipitating antimony by some tartrite - The common
method of boiling an oxide in Crem: tart: is very uncer-
-tain, as the manufacturers are not careful, in removing
all the crystals of impure tartrate of potash. Perhaps the best way of pre-
paring it is to precipitate antimony from its solution

by ~~the~~ a tartrate - as the muriate of ant & by the tartrate of potash. James powder was a compound of oxide of antimony with phosphate of lime. Twenty grains of an oxide of antimony with one gr. of tart: emetic will form a powder exactly similar to the above. — In the preparation of the Antimonial wine there is a great variety of proportions employed - Each apothecary has a formula of his own - & the misfortune is, that the quantity of tart: emet.c is generally too small. In prescribing the wine, as an emetic to a child - it will often be intoxicated before the emetic operat.n is induced - From my own experiments - I have found - that to dissolve perfectly. gr.j. of tart: emet: it is necessary to employ two tea-spoonfuls of distilled vinegar - This fluid, I think should always be employed in preference to the wine - as it keeps equally - & is of one uniform strength. The vinegar also should be fully saturated as then a less quantity is necessary as a dose — Antimony was formerly much employed as an <u>alterative</u> - The practice of exhibiting

medicines as alteratives - that is - to give them in small doses with a view of gradually changing the condition of the system - is in a great measure neglected at present - & I am sorry for it - as it is certainly very useful. —

Arsenic. I have often mentioned that all metals are tonics in proper doses. The metallic are superior to the vegetable tonics - but it is often necessary to alternate their use - but they should never be compounded. Of all tonics, none is so good as Arsenic. It is also an excellent test of the presence of copper - if to a liquor containing copper, a drop of sulphuric acid be added & then a few drops of Fowler's solution - a green tinge will be evident - affording a most delicate test. Some prescribe it - in the form of arsenious acid - this is wrong in as much as it has a nauseous metallic taste - the arseniate of potash as directed by Dr Fowler is the best preparation - Arsenic has been said to cure cancer. I do not know whether cancer has ever been cured, it is like curing a confirmed case of Phthisis Pulmonalis - a thing never done - Some person has compared cancer to a parasite animal - to a

× The dose is not so large as this.

polypous animal - any part of which being left a new ani-
-mal will be formed - Where it is a local disease I should
be apt to treat it as a parasite - & employ caustics &c to kill
it - here arsenic is likely to be as serviceable as any thing else.
It is reported, that this disease has been often cured - it may
be so - I cannot deny it - but there is great difficulty in
discovering whether it is actually a cancer - to determine
this point - the judgment of an experienced surgeon is
requisite - At any rate - I believe, that when ulceration
is established & where absorption has taken place - it is
absolutely incurable

Bismuth - This has been proposed as a remedy for dys-
pepsia - on what theory or indication I know not - but
the oxide of Bismuth is very much in vague - It is
prepared by dissolving the metal in very dilute Nitric or
Muriatic acid - & precipitating it - by pure water. It
was formerly called the magistery of Bismuth - & after-
-wards an oxide - it is however a sub-nitrate - or sub-
muriate. The dose is grs. xx. I have known it often given
but with no good effects - Dyspepsia depends on
general or local debility - when the debility is general

it is to be remedied by air, exercise &c &c: - When local - you must
correct acidity by medicines which will gently purge, for which
purpose, nothing is equal to the Magnesia - after which astrin-
gents & tonics are necessary - as Kino, Columbo &c &c &c, with
respect to Bismuth I think it inert. ———

— When Poisons are swallowed - you first enquire
into all the circumstances of its exhibition - & the symptoms
which succeeded. If the vomiting has been very violent - you
may possibly conclude a metallic poison has been taken -
If great torpor attends - the poison is probably from the nar-
cotics - If there is great vomiting & tormina - it is likely to
be owing to arsenic, corros: subli^e, or copper - as no other mi-
neral poison can usually be procured. If it is copper - it
may be known from the suddenness of the vomiting - there is
little nausea - or heat - the vomiting in such cases is to
be encouraged. If corros: sublimate or arsenic has been
swallowed - there is violent heat produced - then you give
emetics - inspissate some of the matter thrown up & burn it
if you perceive the smell of garlic, it is owing to arsenic.
If corros: subli^e is present - you can detect it by a me-
thod, first noticed in Dr Rees, Encyclopedia. - If you
take a gold ring - & immerse it in the liquor containing

the mercury, no change will be effected - but if you excite a galvanic action, the corros: muriate will be detected but this be done by immersing a piece of a gold ring in the suspected liquor - take a piece of iron wire - ~~on~~ plunge one extremity of it in an acid liquor & apply the other to the Gold - in this way the Gold will decompose the solution & form an amalgam with the mercury —

For further particulars look at the works above referred to ——

—— I have promised to make a few observations on Animal Heat - during the present course of Lectures —— —— It has long been observed, that dead & unorganised bodies change their temperature with that of the atmosphere or bodies to which they were exposed - so that their temperature was perpetually altering — but the facts as to organised bodies differ from those relating to unorganised matter. To whatever temperature living bodies are exposed - within certain points it is found, that they preserve one uniform degree of heat: in warm blooded animals even where the cold is equal to 39° - or the heat equal to 96° - the temperature of their

fluids remains unaltered. As this is the case, then, only in living organised bodies, it is necessary to recur to something which is peculiar to these bodies — with respect to this power in vegetables we have at present nothing to do, altho' it is likely to be conducted on the same principles.

—— There are two principle circumstances, in which organised differ from unorganised bodies — the one is the faculty of breathing — the second that of digesting food. These must therefore depend on something peculiar to such bodies — How are we to account for these? It is first necessary to know the facts which are connected with respiration & digestion. Chemists & they only have pursued this subject so as to get at facts ~~by~~ on which a reasonable theory can be built. But at present we know little more than the difficulties which attend the investigation — About the year 1688 in the reign of Charles the 2nd Dr Hooke & Dr Mayo, first began to suspect, that the air taken ~~in to~~ into the lungs is decomposed during respiration & that the part calculated to support combustion disappeared. Mayo first decomposed Nitre & procured an air in which animals would live & afforded something like a conjecture, that

it was this air which was necessary for respiration —
Dr Black discovered that heat is a chemical substance, that when free its properties were evident, but that it might be combined with other substances, thus becoming latent. & that bodies in assuming different forms always combined with or gave out heat — This Dr Black did not expressly affirm but his experiments tend directly to this point.
Heat I believe to be a substance "sui generis". How any one can explain the chemical fact relating to heat, by words if they believe that it consists in motion, I am at a loss to determine. but there are one or two facts which are demonstrative on this subject. Some consider heat as consisting in the motion of the particles of bodies — let such consider whether there can be a red colour — but of a body that is red — or a blue, but of a body that is blue; motion is a property of a substance, not the substance itself. To say, that a property exists, independent of the body predicated, is grammatical nonsense — Heat is sensible in *every* body — can the motion be the same in every body? is the motion in a piece of red hot iron — or gold the same as that in my skin? can motion be latent in a body? Again we know, that when we put a

lens in the rays of the Sun - that light & heat are both con-
centrated. If a glass be held before the fire - we can see
the light thro' it - but we cannot feel the heat. How is
this if heat be motion? Moreover can ~~to~~ motion be sub-
-ject to chemical combination - bodies can - but I am
~~at~~ at a loss to conceive how motion can? It appears
to me to be a perversion of language to suppose, that
heat can be any thing but a substance, that possesses
properties & enters into combination like any other body.
- This is a digression - Dr Black I observed was afraid
to say, that heat entered into chemical combination -
This opinion was so contrary to those which prevailed
at his time - that he himself was staggered at what was
the direct result of his own experiments - & therefore termed
[illegible] latent heat - But - assisted by the investigations of suc-
ceeding chemists - & by new facts - I cannot hesitate to
affirm that Black's latent heat was caloric chemically
combined with a substance.

Irvine & Crawford pursued the subject of respira-
-tion & first showed that different bodies had diffe-
rent capacities for heat - (still afraid to say diffe-
rent affinities). They attempted to show, that diffe-

-rent gases - had different capacities for heat - that is - that some gases - as gases, *combined* (for I must use the expression) with a greater proportion of heat than others. These experi- were pursued - by showing the quantity of heat given out -by each one - & altho' - these were conducted with great nicety & minuteness - so as indubitably to establish the general fact ~~yet~~ yet as to individual gases, it was doubtful - -Crawford found, that the specific or absolute heat of oxygen was greater ~~in oxygen~~ than in any other air - that if com^n air be one - oxygen would be four. These ex- periments were very delicate - but so much confidence was placed in his accuracy that the general result was taken for granted. Having shown, that the oxygen in the lungs dis- appeared - & that carbonic acid took its place either in whole or in part - he attempted to show, that animal heat depended on the different specific heat of oxygen & car- -bonic acid gas - To this it was objected, that then ar- -terial blood in the left side of the heart should be much hotter than that in the right side - The answer to this was - *no* - as the capacity of the blood while passing from venous to arterial - was also increased - the heat communicated became latent - & in the course of the

circulation - the blood being gradually converted into venous - as gradually gave out - the heat acquired in the lungs. ——— This ingenious theory for a long time prevailed - at last many experiments were made by Fourcroy - Saussure Davis - Allen & Pepys - & many others to ascertain the facts relating to respiration — The results of these investigations were all different so much so that we are very much in doubt as to several important points - 1st As to the quantity of air taken in during one inspiration. Some by breathing into a confined vessel calculated the quantity to be equal to 40. cubic inches - Davy maintained that it varied from 13 to 70 cub. inches; Allen & Pepys calculated it at 16 1/2. inches — This first fact is then undetermined - & therefore what shall we say? what conclusion can be drawn from it! There are one or two other important facts - Allen & Pepys observe that after death the lungs will contain 108 cubic inches of air - Mr Davy says that after a forced expiration, there still remained 41 cubic inches & after a natural expiration - 108 inches — also that by ~~after~~ a forced expiration after a forced inspiration ~~that~~ 190 cu-

-bic inches were expelled; consequently according to them the lungs contained 231. cubic inches of air - Allen & Pepys however made it but 108 - How can we account for this difference? - The next question is how often does a man inspire in a minute - during an easy respiration. The authorities on this point differ as widely as on the others - nothing can be deduced from them. I can only give you what are considered as facts - & you see, how much we are in the dark - — The next inquiry is. What changes are effected during respiration? what are the results of the experiments on this point - Lavoisier & Davy do not disagree very much - they calculate that 31 3/4 ~~40~~ cubic inches of oxygen are consumed in a minute - but it is manifest that there can be no certainty in these calculatns till it is determined what quantity of air is inspired. If I take the chance of reasoning on this subject, I would depend on Lavoisier who ~~ex~~ executed experiments with more accuracy than any one I know. Well then so much oxygen is consumed what becomes of it? Davy & Lavoisier say that the quantity of oxygen disappearing is 31 inches

Allen & Pepys make it 26 — both parties however agree that the oxygen inspired is replaced in bulk by carbonic acid gas. Then we have the fact that oxygen is converted into carbonic acid gas — Well there is another fact — The theory of the absorption of oxygen ~~to~~ by the blood was first advanced by Priestley. He filled a thin bladder with venous blood — & immersed it in a vessel of mercury — the mercury was afterwards displaced by oxygen gas — the consequence was — that the venous was changed into arterial blood — & the mercury arose in the surface in a slight degree. Here then is another experiment which does not render it necessary that oxygen should be absorbed & which overthrows all Crawford's theory — because here the carbon of the blood may unite with the oxygen — & form carbonic acid gas — the volume remaining nearly the same — but how carbon can be emitted by the blood, no explanation has yet been offered — Allen & Pepys thought that there was a small increase of Nitrogen — whether this is the case or not — has not been decided. These are the material facts on the subject of Respiration —

Well - I have detailed you the facts on this subject & you find that on each of these important investi-gations Chemists differ so widely - that we cannot trust any experiment. There is no experiment that will authorize us to believe that oxygen is the cause of the heat of body - Even admitting that Craw-ford's ~~thermometer~~ observations were correct - still I maintain that - there is no ground - for an accurate man to form any conclusion - I believe that the heat of the body has nothing to do with the state of the gases inspired ~~or~~ expired. - Suppose a man to weigh 160 lbs - the weight is calculated to be only 14 or 15 lb. & is evident, that the bones, muscles & other solid parts are much heavier than the fluids of the body - Now all the solid part of our food is digested - all our nutriment is taken into ~~our~~ the sys-tem in a fluid form - the solid, indigestible parts be-ing rejected - It follows therefore all the solids of the body are formed out of the fluids. There is no fact better established in Chymistry - than this - that where a fluid is converted into a solid - heat is

given out. This I fully demonstrated on a former occasion. Well - when during the progress of animal secretion the fluids are converted into solids - must not heat be given out? Can there, then, be any doubt, any hesitation about the source of animal heat? This process is continually taking place in every part - from one extremity of the system to the other - & therefore heat must every where be given out - Is it not as clear as the Sun at Noon day? Hence if you ask why a distant part is heated - the answer is ready - because a solid is there formed from a fluid - & as all heat tends to an equilibrium - the heat of the body is equal in all parts - There is no difficulty in the way ——

2.54.2 ——

Potash
felt spar?
From 1800 tons - dry oak
1 ton of Potash
1200. Hickory 1 ton -
Fir more - grass cold -
Beach - all wood which
contains resin have little or
none -
Procured in Europe from
Russ - Norway Amer.
Can^d - to the ports Riga Dantzic
14^{th} - oak - 4 - Hickory. 6^{th}
Potash in Lycoming
County -
Potass. precipitates Platina
Sodia will not
acid of Tatar with on 1 part
of Potass - insol. Soda very
soluble
Distil of animal sub. produce
Carb. ammon?
44 Lime
7.,20 Mag -

78
60
177
102
07

Malting
keeping the grain moist
for 30 or 40 hours until
it swells - it is then
placed on a floor until
it germinates - it is
then dried to prevent
this process from proceeding -